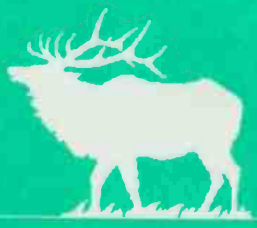
Handbook of Wildlife Chemical Immobilization

Terry J. Kreeger, MS, DVM, PhD



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About the Author

Terry Kreeger is a wildlife veterinarian employed in that capacity by the Wyoming Game and Fish Department. He holds Bachelor degrees in Journalism and Veterinary Science, a Masters degree in wildlife biology, a Doctor of Philosophy degree in Wildlife Management, and Doctor of Veterinary Medicine degree and he is an adjunct professor at both the University of Wyoming and the University of Minnesota. Although he has worked as a zoo veterinarian, his primary interests lie in understanding the ecology of and the management of diseases in free-ranging species as well as research in physiology and pharmacology. He has authored dozens of scientific articles on the chemical immobilization of wildlife and several articles on wild canid physiology and behavior. In 1995, he was part of the capture team that translocated gray wolves from Canada to Yellowstone National Park and Idaho. He currently resides in southeastern Wyoming with his wife, Dr. Julie Kreeger, and son, Andrew, who attends a one-room schoolhouse in Sybille canyon.

About the Publisher

Wildlife Pharmaceuticals Inc. is dedicated to research, development, and manufacture of pharmaceuticals and equipment for the safe and humane management of wild and exotic species. By providing specialized pharmaceuticals essential to veterinary care of non-domestic species, Wildlife Pharmaceuticals Inc. serves the professionals that serve wildlife around the world.

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Dedication

To be honest, writing this book was not my idea. I was fortunate to have two outstanding mentors in graduate school: Drs. Ulysses (Ulie) Seal and Dave Mech. It was Ulie's original idea to write this book and Dave immediately recognized the book's potential and provided encouragement and guidance. Both of these individuals are world reknown and consumate professionals in their fields.

Ulie saw that there was a need for a chemical immobilization manual written for field biologists. He realized that many biologists didn't have the means, or perhaps even the desire, to become experts in chemical immobilization, yet they were ultimately responsible for the capture and handling of wild animals. Many non-veterinarians have expressed a desire for a relatively simple manual that would easily and quickly identify appropriate drugs and doses for immobilizing animals. This manual is not a pharmacology textbook and it is not written for veterinarians, although it is hoped that many veterinarians will find it useful. Rather, I have followed Ulie's original concept of a useful tool for field biologists. I hope I have accomplished this task.

I have also been fortunate to have crossed paths with other true pioneers in wildlife chemical immobilization and I would be remiss in not recognizing their influence on this book as well. I have always admired those in this field who have paid their dues through experience. However, I admire even more so those who published their experience and findings for all the world to share. One of my early heroes was A. M. (Toni) Harthoorn who wrote one of the initial textbooks on animal capture. Dr. Harthoorn was a prolific reporter of his work which benefits all of us to this day. In the same company, I would include Drs. E. Young, V. DeVos, H. Ebedes, U. de V. Pienaar, J. van Heerden, and J. W. Van Nierkerk, all from South Africa. From Canada, Dr. Jerry Haigh should be acknowledged for his efforts to work and publish. Some "young lions" that followed in these footsteps include Jon Arnemo of Norway and Andrew McKenzie from South Africa.

And lastly, I would like to recognize Dr. Harry Jalanka for his pioneering work in the use of medetomidine. I met Harry at a meeting in California. We immediately hit it off and made plans for collaborative work. Incredibly, within a few weeks of that meeting, Harry had died from medical complications. Harry was one of us and he left us all too soon.

Terry J. Kreeger, MS, DVM, PhD
Sybille Canyon, Wyoming
May, 1999

Acknowledgments

I would like to acknowledge several current experts in chemical immobilization who have donated their valuable time in reviewing this manual: Dr. Bill Lance, Wildlife Pharmaceuticals, Fort Collins, Colorado; Dr. Dave Hunter, Idaho Department of Fish and Game, Caldwell, Idaho; Dr. Dave Jessup, California Fish and Gme, Rancho Cordova California; Dr. E. Tom Thorne, Wyoming Game and Fish Department, Laramie, Wyoming; and Dr. Keith Beheler-Amass, Safe Capture International.

Lastly, I would like to thank my wife, Dr. Julie Kreeger, and my son, Andrew, for tolerating my long hours in front of a computer screen, laboriously entering a seemingly-endless stack of references.

Disclaimer

The recommended drugs and doses published in this manual are taken from published scientific articles and textbooks, institutional and personal records, and the experience of the author and his colleagues. Every attempt has been made by the author and the reviewers to insure accuracy of those recommendations. However despite these efforts, errors in the original sources or in the preparation of this book may have occurred. All users of this manual, therefore, should empirically evaluate all dosages to determine that they are reasonable prior to use. Animal anesthesia is obviously beyond the control of anyone other than the person directly responsible for the immobilization. The vagaries of conditions, weather, age, nutrition, disease, and stress make every immobilization process unique. Because of this, the author and publisher cannot accept responsibility for mishaps should they unfortunately occur. In addition, the author and publisher do not endorse specific products, procedures, or dosages reported in this manual. Also, the listing of a drug in this manual does not indicate approval by the Food and Drug Administration or the manufacturer for use on wildlife.

Preface

Early attempts to chemically immobilize wild animals were "stimulating" for both the animal and the biologist. Limited anesthetic selection and lack of remote delivery systems required prior capture or restraint of the animal necessitating up close and personal drug administration. In the last decade, however, rapid development of injectable anesthetics in human and veterinary medicine plus improved delivery systems have benefited everyone involved with animal capture. There have been many individual reports on the use of these newer drugs, but no contemporary, single publication has incorporated these latest developments under one cover. This manual is intended to provide wildlife biologists, wildlife and zoo veterinarians, game ranchers, animal control personnel, and students with a portable reference for the chemical immobilization of non-domestic animals. Although this manual is comprehensive, it should not replace personal instruction by qualified professionals. In addition, a First Aid/CPR course is highly recommended for all users of capture drugs.

This manual is designed to accompany the user into the field and should act as a rapid reference source for those faced with the challenge of chemically immobilizing a wild, and often uncooperative, animal. Its format is intentionally brief, serving to highlight, rather than detail, the salient aspects of each section. Those desiring a more in-depth discussion should seek out the relevant literature offered. Despite the emphasis on brevity, it behooves the novice to be familiar with the general properties of the drugs that he or she intends to employ. Such preparation could save some surprises in the field when one encounters an unexpected reaction attributable to the drug.

The Drug Dose section is designed to rapidly locate the species of interest and select an appropriate immobilizing agent. Many previous publications on drug doses would list the species plus several different drugs, dose ranges, and combinations - much to the anguish and confusion of the first-time user who, through inexperience, was overwhelmed to the point of inaction by the choices offered. I hope that this manual eliminates such quandaries. I have compiled and analyzed drugs and doses from published reports or private records and then made a single recommendation for a given species based on my, and others, experience with the drug and species. Other drug choices and appropriate references are also included should you not agree with or not have available the recommended drug(s). The primary recommendation does not necessarily mean that the chosen drug(s) is always the best choice under all circumstances. Experience with the various drugs will eventually allow you to make informed choices on your own.

Also included are chapters on Animal and Human Emergency Treatment. Again,

these are intended to serve as quick reference sources to recognize and treat the most common emergency conditions encountered in the field, but not as a definitive treatise on emergency medicine. These sections are highlighted for rapid access and both have a quick reference guide at the beginning of each section.

In the Equipment chapter, I was not reluctant to point out deficiencies or praise performance. Such praise, however, does not convey endorsement of the product.

Lastly, you probably have noticed that this handbook was not produced by a big-name publisher. This was done so as to keep the price of the book within reason and hopefully available to almost everyone, including students. I hope that this decision does not cause anyone undue difficulty in obtaining this handbook.

Capture Drugs

Legal Considerations

The legalities surrounding the purchase, storage, and dispensation of drugs used for wildlife immobilization vary from country to country. It is beyond the scope of this manual to detail each situation, so the following discussion primarily applies to North American users of immobilizing drugs.

United States

Conditions for the use of drugs (pharmaceuticals) to sedate or anesthetize animals are established by the Food and Drug Administration (FDA). The FDA verifies the safety and efficacy of drugs as well as insures manufacturing quality control. Drug manufacturers must undergo a lengthy and expensive process of drug testing to receive FDA approval. Approval by the FDA, when granted, limits the use of the drug to conditions specified on the label, i.e., the intended species, the dose, conditions of use, withdrawal times, and the like. *Any use of the drug other than what is specified on the label is technically in violation of federal regulations.*

Many of the drugs used for wildlife immobilization are termed *controlled* substances. A controlled substance means a drug that is identified in one of five schedules. Federal legislation governing the possession of controlled substances is contained in The Controlled Substances Act (1970). The Drug Enforcement Administration (DEA) is the U.S. federal agency charged with enforcing provisions of this act. Special regulations govern the recording and storage of these drugs. The Controlled Substances Act requires an individual to have a special DEA registration number in order to possess controlled substances. Application for this number is made through regional offices of the DEA. If you are unable to determine your regional office, contact the United States Department of Justice, Drug Enforcement Administration, Washington, D.C. 20537. Holders of professional medical degrees (D.V.M., M.D. etc.) should submit a DEA Form 224 to apply for a registration number. All others should submit a DEA Form 225. Re-

newal is required every three years. Following is a brief discussion of the five schedules:

Schedule I – This is reserved for experimental and abused drugs such as heroin, marijuana, and lysergic acid diethylamide (LSD). Use of Schedule I drugs requires a separate registration number. Application for Schedule I requires the same forms listed above, but the application should request registration only for Schedule I substances. Schedule I drugs are primarily limited to research use.

Schedule II (IIN) – This includes most of the opioids used for animal immobilization, such as etorphine, fentanyl, and carfentanil and the opioid antagonist, diprenorphine. Phencyclidine and some barbiturates are also in this schedule.

Schedule III (IIIN) – This contains several barbiturates and tiletamine/zolazepam (Telazol®).

Schedule IV – Includes benzodiazepine tranquilizers such as diazepam and midazolam.

Schedule V – This covers small, limited quantities of narcotic drugs included in preparations with non-narcotic active medicinal ingredients.

Currently, commonly-used immobilizing agents such as ketamine, xylazine, and the phenothiazine tranquilizers are *not* controlled substances.

All approved drugs used on wildlife are prescription drugs and must be used *by or on the order of a licensed veterinarian.* Many biologists have obtained a DEA registration number and have been able to procure drugs through veterinary product distributors. Technically, however, even though they are in possession of these drugs, they cannot *use* them on animals without veterinary approval. Biologists who use veterinary prescription drugs without the involvement of a licensed veterinarian should know that they are in violation of federal regulations. The FDA requires that a valid veterinarian/client/patient relationship be established. That is, the biologist becomes the "client" and the wild animal becomes the "patient." The biologist consults with the veterinarian on the use of the drug who determines if the dose and application is appropriate. The veterinarian does *not* have to be on site during the immobilization process, but he or she should be involved in the planning process. More specifically in the case of animal control (or wildlife) agencies operated either by state or local governments or by government sanctioned non-profit organizations, the FDA will consider the use of veterinary prescription drugs by lay persons to conform to their requirements [21 CFR 201.105(c)] if there is a staff or consulting veterinarian who obtains the drugs and the drugs are used under his or her general supervision and authority. This means that the veterinarian should provide the lay user with sufficient assistance and instruction and be assured that the drugs are properly used.

To further confuse matters, only four drugs have been specifically approved by the FDA for use on certain wild animals: carfentanil for use on cervids; xylazine for use on elk and fallow, mule, sika, and white-tailed deer; yohimbine for use on cervids (deer and elk); and ketamine for use on primates. Any use of these or other drugs on any species not identified on the label is termed "extra label" or "off label" and used to be in technical violation of federal regulations.

Animal Medicinal Drug Use Clarification Act of 1994

However, the Animal Medicinal Drug Use Clarification Act of 1994 (AMDUCA; passed into law in 1996) essentially allowed veterinarians to use approved animal and human drugs extra label under certain conditions. The AMDUCA makes a specific distinction between food and non-food animals. Therefore, you must consider the possibility of an animal being harvested and consumed by a human subsequent to your capturing it with drugs. Below are listed criteria for extra label drug use in food and non-food animals. There are other restrictions for certain human drugs and drugs specifically prohibited for use in food-producing animals, but such drugs are usually not used for animal capture and will not be discussed here.

Extra label use of animal or human drugs is allowed in *non-food* animals if the drug is: 1) approved by the FDA; 2) used by or on the lawful written or oral order of a licensed veterinarian; and 3) used within the context of a valid veterinarian/client/patient relationship.

Extra label use of FDA-approved animal or human drugs is allowed in *food* animals if there is no approved animal drug labeled for such use or the approved drug is clinically ineffective for its intended use. Prior to extra label use of immobilizing drugs in food animals (e.g., deer, elk, bear, sheep, pronghorn, etc.), the veterinarian must: 1) establish a substantially extended withdrawal time (see page 11); 2) be able to identify the treated animals; and 3) assure that assigned timeframes for withdrawal are met and no illegal residues occur.

The establishment of withdrawal times and the identification of free-ranging food animals that have been chemically immobilized and released during hunting season are major concerns for state wildlife management agencies. The Western Wildlife Health Cooperative (a coalition of western state health officials) has drafted a policy that may provide guidance in this area, but this policy has not been approved as of this writing.

Canada

In Canada, holders of medical degrees must write the Director, Bureau of Dangerous Drugs, Health Protection Branch, Health and Welfare Canada, Ottawa, Ontario K1A 1B9 each time narcotics are to be purchased. Once approval is obtained, the individual can submit the order to the pharmaceutical company or licensed dealer.

Individuals not possessing a medical degree must satisfactorily complete a 2-3 day course of instruction administered by the Bureau of Dangerous Drugs in order to become a person "authorized" to possess narcotics. This person must then make a request to the Bureau of Dangerous Drugs for *each* project. Upon approval of the project, the Bureau of Dangerous Drugs will notify the authorized person as well as notifying the appropriate licensed dealer of the authorization.

Records

Individuals in both the U.S. and Canada possessing narcotics (Schedule II) are required to maintain records of their use. An inventory record must be maintained containing at least the following information:

Purchase Inventory:

Type of narcotic received (e.g., etorphine, carfentanil, etc.)
Amount received
Date received
From where narcotic received (i.e., name of manufacturer or distributor)

Use Inventory:

Amount used
Date used
Species used on
Reason for use

Many users of Schedule II immobilizing drugs number each bottle and maintain a running inventory of the amount of drug used, opening a new bottle only when the previous bottle is empty. Drug use must be reconciled with drug received. That is, if you received 50 ml of etorphine, you must account for 50 ml used. Reasons for use include not only administration to animals, but also missed darts, accidental spillage, and intentional disposal of unused drug. Records must be maintained for two years and inventories should be taken biannually. Records of receipts of drugs in Schedules II, III, IV, and V must be kept in an "easily retrievable manner".

The AMDUCA also has specific record requirements for extra label drug use. The prescribing veterinarian is ultimately responsible for these records, although the end user should also maintain the same information. When drugs are used extra label, the following information should be recorded:

1) Name of drug and active ingredient
2) Condition treated (e.g., capture for translocation)
3) Dosage administered
4) Duration of treatment (usually not applicable for capture)
5) Number of animals treated
6) Specific withdrawal time (for food animals)

Potential food animals should be identified in some manner (ear tag, collar) if there is a possibility that the animal could be killed during the withdrawal period and subsequently eaten by a hunter. This identification probably will have to either: 1) warn the hunter not to consume the meat if harvested before a certain date, or 2) require the hunter to notify the appropriate wildlife management agency who will then determine if the animal can be safely eaten.

Records are valuable for reviewing efficacy of the drugs and doses, for keeping track of samples, and for determining reasons for adverse reactions. Record format is as diverse as the individuals designing them; an example of a comprehensive drug immobilization record is included on Page 10.

It is usually useful to have several blank spaces for drugs administered and vital signs so that you can maintain a running record of the drug and medical history. Below is an example of a record of an animal darted and then given additional drugs. Note that both ketamine and xylazine are listed as being given at 9:00 a.m. indicating that they were administered in the same dart. Also note that in the location column, you can indicate if the injection was IM, IV, or SC, if desired.

Time	Drug	Dose (mg or ml)	Method	Location
0900	Ketamine	400 mg	Dart	L. Hip
0900	Xylazine	100 mg	Dart	L. Hip
0910	Ketamine	200 mg	Pole	Shoulder
0940	Penicillin	5 ml	Hand	R. hip
1000	Yohimbine	7 mg	Hand	Jugular, IV

Ordering and Storage

All Schedule II controlled substances must be ordered on a DEA form 222 which is preprinted by the DEA and issued to the holder of the DEA registration number. This form must be sent to the manufacturer or distributor. However, before any drug is shipped, the holder must have approved storage facilities for these drugs. Schedule II controlled substances, particularly etorphine and carfentanil, must be stored in a safe or steel cabinet equivalent to a U.S. Government Class 5 security container. This usually means a safe weighing more than 750 lb or a safe that is bolted to the floor with the bolts brazed in such a manner as to prevent tampering. The local DEA office must then physically inspect the storage container and send their recommendations for approval to the DEA in Washington. The DEA will then notify the manufacturer or distributor that the individual is approved.

All other controlled substances must be stored in a secure place with limited access. Regulations regarding drug storage are contained in 21 CFR 1301.75d. If you have any questions regarding drug storage, contact your local DEA office or call the DEA Policy Unit in Washington, D.C. (202-307-7297).

ANIMAL CAPTURE FORM

Date _____ Animal number _____
Name of investigator(s) _____
Species _____ Sex (circle) M F UNK
Age _____ mo yr (estimated or actual)
Weight _____ lb kg (estimated or actual)
Purpose of capture _____
Location of capture _____
Ambient temperature _____ F° C° Weather conditions _____

Time	Drug	Dose (mg or ml)	Method	Location

Time animal immobilized _____ Time animal recovered _____

Vital signs:	Time	Temperature	Pulse	Respiration

Condition of animal - indicate: excellent good fair poor
Injuries or abnormalities noted _____

Sample(s) taken:	Time	Type (indicate blood, tissue, tooth, etc.)

Radio collar frequency _____ Radio Signal Checked? ___
Transponder number _____ Transponder Checked? ___
Ear tag number(s) and color(s) _____

Other Measurements:
Body Length _____ cm Tail Length _____ cm
Shoulder Height _____ cm Girth _____ cm

Comments:

Labeling

All approved drugs are labeled by the manufacturer and such labels should not be altered. It is a good idea, however, for lyophilized drugs such as Telazol® to indicate on the label the date on which the drug was reconstituted. Such drugs have a specified shelf life from the date of reconstitution. If for some reason, drugs are transferred to an unlabeled container, be sure to indicate on that container the name and the concentration of the drug as well as its expiration date which appeared on the original container. Never use drugs from an unlabeled container - if in doubt, throw it out!

Human Consumption of Drugged Animals

A "withdrawal time" is a time established by the FDA that specifies the period of time that must expire from the date that a drug was administered to when the animal can safely be consumed by humans. In the U.S., many of the animals chemically captured are food-producing animals (e.g., deer, bear) and many are captured just before or during their hunting seasons. Also, many of the animals are captured using drugs extra label. The FDA has concerns that drug residues may remain in animal tissues, be consumed by humans, and result in an adverse reaction. Thus, the AMDUCA emphasizes the need for establishing withdrawal times for animals that could be consumed by humans. Unfortunately, there currently are *no* scientifically-established tissue residue studies (which are used to establish withdrawal times) for any of the drugs used on any of the species in the U.S. The prescribing veterinarian must therefore use whatever information is available and apply it in a conservative manner to the extra label application. For example, tissue residue studies for ketamine may exist for a certain species of primate. These data may serve as a basis for the withdrawal time for ketamine used in deer.

For some guidance, I have listed the withdrawal times for certain drugs used in a theoretical 70-kg deer as established by the Food Animal Residue Avoidance Database (FARAD). When in doubt, a conservative withdrawal time of *at least 45 days* should be sufficient for other drugs and other species.

Drug	Dosage	Withdrawal Time (days)
Carfentanil	0.026-0.086 mg/kg	30[a]
Ketamine	5 mg/kg	3
Xylazine	2 mg/kg	10-30[a]
Yohimbine	0.2-0.3 mg/kg	30[a]
Penicillin (procaine G)	30,000 IU/kg	21

[a]FARAD recommends that these drugs not be used in free-ranging cervids within 30 days of hunting season.

General Principles

Drug Characteristics

Obviously, no perfect capture drug exists; if it did, there would be little need for this book. However, the characteristics of an ideal injectable anesthetic may serve as guide to the evaluation of currently available immobilizing drugs for wildlife. These criteria include both physical and pharmacological properties as well as desirable properties for an immobilizing agent. These criteria are as follows with no specific priority implied:

- High therapeutic index (the amount of drug causing death versus the amount of drug producing the desired effect)
- Potent (sufficient dose delivered in small volume)
- Rapid, smooth onset of action following IM or IV administration
- Minimum excitement phase
- Nonirritating following intravenous (IV) or intramuscular (IM) administration
- Good muscle relaxation
- Minimal depression of cardiovascular or respiratory systems
- Analgesia at subanesthetic levels
- Retention of reflexes, i.e., swallowing
- Causes minimal fear, pain, or distress
- Capable of being antagonized, preferably graded antagonism
- Rapid, smooth emergence (short elimination half-life) with minimal side effects
- Rapid degradation to inactive, nontoxic metabolites
- Highly water-soluble, stable in solution, and long shelf-life
- Produces an amnestic effect
- Safe for pregnant animals
- Safe for humans should accidental exposure occur
- Low potential for human abuse

Calculating Drug Doses

Accurate calculation of drug doses is critical to reduce the problems associated with under- or overdosing. Information required prior to calculating dose includes:

Animal's Weight

If you lack experience with the average weights by age class of your particular species (male, female, juvenile), either contact someone who has experience or use the information included in this manual on the specific species. Try to train yourself to think of weights in metric units because this is standard scientific notation and it is the measurement system used by most countries. A conversion table of pounds-to-kilograms is presented on page 340. This table provides a quick conversion of pounds to kilograms without having to use a calculator.

Concentration of the Drug

Most manufacturers provide concentrations of their products in milligram (mg) of drug per milliliter (ml) of solvent (mg/ml). Some concentrations are expressed as percents, i.e., a "10%" solution. A 100% solution means that there is 1 gram (1 gm = 1,000 mg) of drug dissolved in 1 ml of solvent. Therefore, a 10% solution means that there is 100 mg (0.10 x 1,000 mg) of drug in 1 ml of solvent (i.e., 100 mg/ml).

Some drugs are freeze-dried (lyophilized) and you may only have the weight of the dried preparation. To prepare a solution of known concentration you must calculate backwards from the desired solution to arrive at the volume of solvent to add to the powdered drug. That is, if a drug bottle contains 500 mg of drug and you desire a 100 mg/ml solution, you must add 5 ml of solvent to the bottle.

$$\text{Desired Concentration} = 100 \text{ mg / ml} = \frac{500 \text{ mg drug}}{\text{? ml of solvent}}$$

$$\text{? ml of solvent} = \frac{500 \text{ mg drug}}{100\text{mg / ml}} = 5 \text{ ml solvent needed}$$

The actual concentration of this dilution, however, will be *less* than 100 mg/ml because the volume of the lyophilized drug is not taken into consideration in the total solution volume. For example, if the lyophilized drug volume was 0.3 cubic centimeters (roughly 0.3 ml), then the total volume in the bottle after adding 5 ml of solvent would be around 5.3 ml (actually somewhat less considering chemical reactions). Thus the *actual* concentration is 94.3 mg/ml (500/5.3). Unfortunately, this error is common in drug formulations and recommended drug doses, although its continued use does maintain consistency if not accuracy.

Dose Rate

In this manual, doses are mostly given as mg of drug per kilogram (kg) of animal body weight (mg/kg). To convert kg to pounds (lb), multiply kg by 2.2 (e.g., 10 kg = 22 lb). Conversely, to convert lb to kg, multiply lb by 0.45 (e.g., 100 lb = 45 kg). Again, a conversion table of pounds-to-kilograms is presented on page 340. Armed with the above information, you can now calculate the drug dose.

For example, consider immobilizing an animal that weighs 80 kg (176 lb) with Drug "X". The recommended dose of Drug X for this animal is 5 mg/kg. Drug X is available in a 100 mg/ml solution. First, calculate the *total mg* needed for this animal by multiplying the animal's weight (80 kg) by the recommended drug dose (5 mg/kg):

$$\text{mg Drug X needed} = 80 \text{ kg} \times 5 \text{ mg/kg} = 400 \text{ mg}$$

Then calculate the *volume* of drug solution to withdraw from the bottle by dividing the needed total mg of Drug X (400 mg) by its concentration (100 mg/ml):

$$\text{ml volume needed} = \frac{400\ \text{mg}}{100\ \text{mg / ml}} = 4\ \text{ml of drug solution}$$

Some Points to Remember in Calculating Drug Doses

Never memorize drug doses.

This is one of the cardinal rules of pharmacology and one we all probably break at one time or another. However, we also all make a mistake at one time or another. It's incredibly easy to mix up doses when you are in a hurry or otherwise pressured. Also, time has a way of eroding memory, so don't trust it.

If you're not sure, don't use it!

Never use drug solutions where the name of the drug and its concentration are not on the label.

Physically calculate drug doses.

Unless you continually perform mental calculations, take time to use a calculator or paper and pencil to correctly figure doses.

Calculate the dose at least twice.

Regardless of the method of dose calculation, it is always a good idea to double check your math.

Look at your answer.

After you have calculated the dose twice, does it seem appropriate for the situation? With drug and animal experience, a dose that is miscalculated should trigger a mental alarm.

Drugs Used for Chemical Immobilization

This section introduces the various types of drugs commonly used to immobilize wild animals. Drugs are presented by class or group with individual drugs categorized by chemical name.

Drug Combinations

Although drugs are discussed individually in this section, they are often employed in combination for wildlife immobilization.

The advantages for combining drugs include:

- Reduction of dosage of all drugs in combination (Figure 1)
- Reduction of undesirable side effects (convulsions, muscle rigidity, etc.)
- Decreased induction time
- Improved recovery

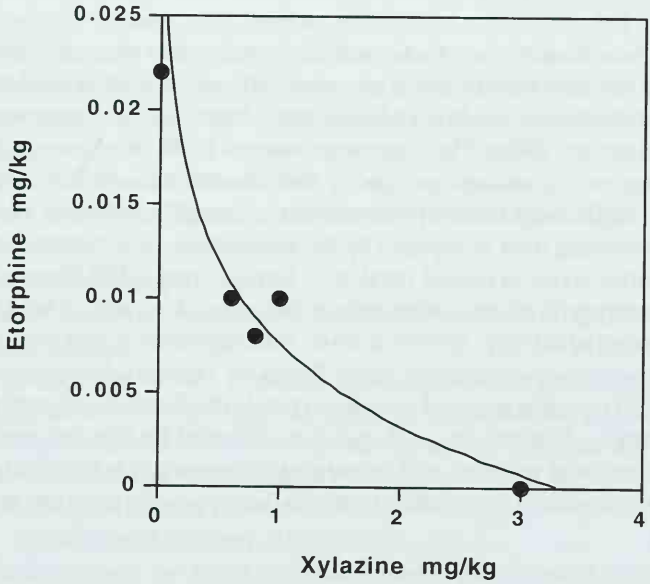

Figure 1. Combining two drugs reduces the amount of each drug required to achieve a desired effect as compared to the amount required for either drug when used alone (after Röken, 1975). Points indicate drug concentrations of xylazine and etorphine that resulted in satisfactory immobilization.

Disadvantages of drug mixtures include:

- Difficulty in assessing individual drug effect
- Increased complexity in calculating initial drug doses
- Confusion of appropriate doses if initial combination was insufficient for immobilization
- Prolonged recovery with some combinations
- Potentiation of adverse effects (e.g., respiratory depression)

In this manual, we will often discuss drug combinations in terms of two components, the primary immobilizing agent and the secondary agent or adjunct. In general, primary agents are capable of immobilizing an animal by themselves, providing enough is administered; secondary agents usually cannot effect complete immobilization regardless of dose. Some common examples of drug combinations include (primary/secondary agent) ketamine/acepromazine, ketamine/xylazine, ketamine/medetomidine, etorphine/acepromazine, etorphine/xylazine, carfentanil/xylazine, fentanyl/azaperone, tiletamine/zolazepam, and tiletamine/zolazepam/xylazine.

Neuromuscular Blocking Drugs

Curare, the South American arrow poison, probably typifies this class of drugs. The neuromuscular blocking (NMB) drugs are some of the earliest drugs used for the chemical immobilization of wildlife and their use in human clinical situations probably dates back to the 1930's. There are two classes of NMB drugs, competitive and depolarizing, which are distinguished by their electrophysiological properties. Competitive NMB drugs occupy postsynaptic cholinergic receptors in skeletal muscle thus preventing their occupancy by the endogenous neurotransmitter, acetylcholine, and they result in flaccid paralysis. Depolarizing NMB drugs act by depolarizing postsynaptic membrane receptors, thus mimicking acetylcholine, but with a longer period of activity. Immobilization with depolarizing NMB drugs is characterized by an initial transient rapid firing of the muscles (muscle fasiculations), which is quickly replaced by general paralysis. The order of paralysis is sequential, starting from the jaw, tail, and face, followed by legs and neck, throat, abdomen, intercostal muscles, and diaphragm. Recovery is in the reverse order. Overdosing with either class of drug results in diaphragmatic paralysis and death by asphyxia.

The effects of competitive NMB drugs can be antagonized by anticholinesterase drugs which inhibit the enzymatic action of cholinesterase resulting in increased levels of acetylcholine. Acetylcholine has a stronger affinity for the receptor than the NMB drug, thus causing diffusion and diminished rebinding of the NMB drug. Because the antagonist activity of anticholinesterase drugs does not specifically neutralize the NMB drug, the effect of the anticholinesterase drugs may be dissi-

pated before complete elimination or metabolism of the NMB drugs resulting in recycling and renewed paralysis. Also, overdosing resulting in death is possible with anticholinesterase drugs.

Despite their long history of use, NMB drugs are generally inferior to modern drugs. There are two major deficiencies of NMB drugs. One is that NMB drugs have a very low therapeutic index and dosage errors of only 10% can result in either no effect or death (IWVS, 1992). Mortality rates as high as 70% have occurred. The second deficiency is that NMB drugs are virtually devoid of central nervous system (CNS) effects because of their inability to cross the blood-brain barrier. Thus, an animal paralyzed with NMB drugs is conscious, aware of its surroundings, fully sensory, and, as such, can feel pain and experience psychogenic stress yet is physically unable to react. Because of these deficiencies, NMB drugs should be used judiciously.

There are, however, certain definite advantages to some NMB drugs. They are generally very fast-acting (3–5 min) and the duration of effect lasts only for a short while (15–30 min). Succinycholine, the most commonly used drug of this class, is also fairly safe for humans. Unlike some other drugs, the succinycholine dose required to immobilize most animals is much lower than the clinically effective dose for humans. Also, animals that have been given only succinycholine and that have died or been euthanized using physical means (i.e., not other drugs) can be safely eaten by other *animals*, if needed. Although deer have been intentionally killed with arrows tipped with succinylcholine and then eaten by humans, it must be remembered that succinylcholine has not been approved by the FDA for use on any animal, let alone animals intended for human consumption. And lastly, succinycholine is extraordinarily cheap, perhaps the least expensive immobilizing agent available. This might explain why it is still in widespread use.

Succinylcholine

Trade Name(s): Anectin®, Sucostrin®, Scoline®, Quilicine®, Miradine®, Suxamethonium®.

Mechanism of Action: Depolarizing neuromuscular blocking agent.

Clearance: Hydrolyzed by butyrylcholinesterase in liver and plasma to succinylmonocholine which is broken down into succinate and choline.

Routes of Administration: IM, IV, IP.

Advantages: Usually rapid induction (3–5 min).

- Usually rapid recovery (15–30 min).

Disadvantages: No effect on consciousness, pain threshold, or cerebration.

- Low therapeutic index requires precise weight estimation; overdose leads to respiratory paralysis and death.
- Can cause bradycardia, tachycardia, or cardiac arrest (due to exacerbation of hyperkalemia in animals having extensive tissue damage or being overly exerted).

- Can cause muscle soreness upon recovery probably caused by potassium release.
- Can release histamine resulting in bronchospasm, hypotension, salivation, and bronchial secretion.
- Can alter packed cell volume, total plasma protein, glucose, aspartate aminotransferase, cortisol, and progestin values.
- Prolonged muscle relaxation can cause hypothermia in small animals.
- Can cause malignant hyperthermia in some species.

Antagonists: None; anticholinesterases will actually prolong effect of depolarizing drugs.

Formulation: 20, 50, or 100 mg/ml solution; 500 and 1,000 mg sterile powder. Keep refrigerated and use quickly after withdrawing into syringe or dart.

Comments: Not controlled substances. Use of succinylcholine is probably best limited to captive situations where problems can be quickly addressed. In white-tailed deer and perhaps other species, the effective dose of succinylcholine can vary with time of year (Jacobsen et al., 1976).

Gallamine, Tubocurarine, Metocurine, Pancuronium, Vecuronium, Atracurium, Alcuronium

Trade Name(s): Flaxedil® (gallamine); Metubine Iodide® (metocurine); Pavulon® (pancuronium); Norcuron® (vecuronium); Tracrium® (atracurium); Alloferin® (alcuronium).

Mechanism of Action: Competitive neuromuscular blocking agents.

Clearance: Gallamine, tubocurarine, and metocurine are excreted in urine virtually unchanged; pancuronium, atracurium, and vecuronium undergo various degrees of metabolism. Vecuronium is metabolized the most and thus has the shortest duration of action.

Routes of Administration: IM.

Advantages: Effective immobilization of crocodilians, particularly gallamine.

- Can be antagonized.

Disadvantages: No effect on consciousness, pain threshold, or cerebration.

- Low therapeutic index requires precise weight estimation; overdose leads to respiratory paralysis and death.
- Tubocurarine can release histamine resulting in hypotension, bronchospasm, and secretions.
- Gallamine can cause tachycardia and hypertension because of selective blocking of the cardiac vagus nerve.

Antagonists: Physostigmine, neostigmine, edrophonium, pyridostigmine.

Formulation: Tubocurarine: 3 mg/ml solution.

- Metacurine: 2 mg/ml solution.
- Gallamine: 20 mg/ml solution.
- Pancuronium: 1-2 mg/ml solution.
- Vecuronium: 10 mg vials.
- Atracurium: 10 mg/ml solution.

- Alcuronium: 5 mg/ml solution.

Comments: Not controlled substances. The same caveats for succinylcholine apply to competitive NMB drugs. Competitive NMB drugs should not be used in conjunction with opioids, corticosteroids, inhalation anesthetics, aminoglycoside antibiotics, tetracycline, polymixins A and B, clindamycin, or lincomycin due to significant interactions.

Nicotine

Mechanism of Action: Depolarizing muscle relaxant acting primarily on the autonomic ganglia as opposed to the myoneural junction.

Clearance: Metabolized in the liver, kidney, and lung and excreted by the kidneys.

Routes of Administration: Primarily IM, but nicotine can be absorbed through the skin or mucous membranes (eyes, mouth).

Advantages: None.

Disadvantages: Doses used to immobilize animals are more than sufficient to *kill* humans should accidental absorption occur.

- Low therapeutic index requires precise weight estimation.
- Nicotine can cause complex and unpredictable physiological reactions including bradycardia, tachycardia, hypertension, convulsions, vomiting, tachypnea.

Antagonists: None.

Comments: Not controlled substances. Immobilization is characterized by an initial transient stimulation followed by a persistent depression of all the autonomic ganglia. This stimulatory phase can be obscured by paralysis, which rapidly develops at the myoneural junction. Although rarely seen today, nicotine should not be used under any circumstances for animal immobilization. It is potentially lethal to both humans and animals and there are many superior drugs readily available.

Tranquilizers/Sedatives

Tranquilizers are used primarily in wildlife immobilization as adjuncts to primary immobilizing agents (opioids, cyclohexanes) to hasten and smooth induction and recovery and to reduce the amount of the primary agent required to achieve immobilization. There are four major categories of tranquilizers - major tranquilizers or neuroleptics (phenothiazines and butyrophenones), minor tranquilizers (diazepinones), alpha-adrenergic agonists, and serotonin (5-HT) blockers. Tranquilizers such as droperidol and zolazepam will be discussed elsewhere as they are generally used only in conjunction with other agents.

Long-acting tranquilizers (LATs) also will not be discussed in detail here because they are not used to immobilize animals. Rather, LATs are used in the transport and holding of wild animals to calm them and reduce aggression. LATs consist of esterified tranquilizers in an oil base. This formulation allows slow release and

prolonged effect, sometimes for several weeks. Although used extensively in southern Africa, LATs are not available in North America. Readers interested in LATs are referred to Ebedes, 1991; 1992a; 1993; Ebedes and Burroughs, 1992; Holz and Barnett, 1996.

Phenothiazine tranquilizers (promazine, acepromazine) were originally developed as antipsychotic drugs. They are sometimes referred to as neuroleptics, referring to a syndrome characterized by suppression of spontaneous movements but retention of spinal reflexes and nociceptive (pain)-avoidance behavior. Azaperone is a butyrophenone neuroleptic which has been reported to stimulate respiration in pigs and to counteract narcotic respiratory depression in wild animals (Marsboom, 1969).

Benzodiazepine derivatives are used primarily in wildlife immobilization as an anticonvulsant adjunct to the cyclohexane anesthetics and they are also excellent muscle relaxants. Benzodiazepine antagonists have been developed that could reduce recovery times.

The alpha-adrenergic agonists are potent sedatives and can be completely antagonized. They are usually used as adjuncts with opioids or cyclohexanes to hasten and smooth anesthetic induction. By themselves, they are capable of heavily sedating animals, particularly ungulates, to the point of relatively safe handling. However, animals sedated with alpha-adrenergic agonists generally can be aroused with stimulation and are capable of directed attack. Caution should always be exercised in such animals even though they appear harmless.

Acepromazine, Promazine

Trade Names: PromAce®, Atravet®, Notensil®, Plegicil® (acepromzine); Sparine® (promazine).
Mechanism of Action: Antagonize the neurotransmitter, dopamine, in the basal ganglia and limbic portions of the forebrain.
Clearance: Hepatic oxidation and glucuronic acid conjugation with renal excretion.
Routes of Administration: IM, IV, SC.
Advantages: Smooth anesthetic induction and recovery.

- Potentiates analgesic and anesthetic properties of other drugs.
- Antiemetic (decreases vomiting).
- Relatively safe drugs (high therapeutic index).

Disadvantages: Can cause hypotension with reflex tachycardia.

- Can potentiate respiratory and cardiovascular depressant effects of opioids.
- Can disrupt thermoregulatory mechanisms thereby increasing susceptibility to hypo- or hyperthermia.
- Can cause temporary or permanent penile prolapse in domestic stallions (assume same for wild or feral horses).
- Can increase glucose levels, increase prolactin secretion, decrease adrenocor-

ticotropin and corticoid secretion, and decrease urinary concentrations of gonadotropins, estrogen, and progesterone.

- Can block ovulation, suppress estrus, and cause infertility.

Antagonists: None.

Formulation: Promazine: 50 mg/ml solution.

- Acepromazine: 10 mg/ml solution or 10 and 25 mg tablets.

Comments: Not controlled substances. Of the two phenothiazine tranquilizers, acepromazine is more potent, but promazine has a markedly reduced duration of effect. Clinical effects of acepromazine can last from 4–8 hr and up to 48 hr in older animals. Promazine is currently not being manufactured, but many distributors maintain stocks and it may be manufactured again in the next few years.

Azaperone

Trade Names: Stresnil®, Suicalm®.

Mechanism of Action: Antagonize the neurotransmitters, dopamine and norepinephrine, in the CNS; mimics the neurotransmitter, gamma-amino-butyric acid, in extrapyramidal system.

Clearance: Hepatic oxidation and glucuronic acid conjugation with renal excretion.

Routes of Administration: IM, IV, SC.

Advantages: Smooth anesthetic induction and recovery.

- May increase respiration.
- Minimal cardiovascular and thermoregulatory effects.
- Relatively safe drug (high therapeutic index).
- Short acting.

Disadvantages: Could cause excitement in horses at low doses.

- Causes drop in blood pressure upon administration.

Antagonists: None.

Formulation: 40 mg/ml solution.

Comments: Not controlled substance.

Diazepam, Midazolam

Trade Name(s): Valium®, Zetran® (diazepam); Versed®, Dormicum® (midazolam).

Mechanism of Action: Potentiate inhibitory effects of gamma-aminobutyric acid (GABA) neurotransmitter.

Clearance: Hepatic oxidation and glucuronide conjugation with excretion in urine and feces.

Routes of Administration: IM, IV, SC, PO.

Advantages: Good muscle relaxant.

- Anticonvulsant; particularly useful in decreasing cyclohexane-induced convulsions.
- Minimal respiratory and cardiovascular effects (but see comments).
- Very safe agents.

Disadvantages: Diazepam is poorly absorbed IM.

- Low potency; generally require large volumes when used in combination with immobilizing agents.

Antagonists: Flumazenil (Anexate®).

Formulation: 5 mg/ml solutions; 2, 5, 10 mg tablets.

Comments: Controlled substances (Schedule IV). Diazepam is solubilized in 40% propylene glycol which may produce hypotension, bradycardia, apnea, and cardiac arrest if injected too rapidly IV. Midazolam is in an aqueous base and does not cause these cardiovascular reactions.

Xylazine, Detomidine, Medetomidine

Trade Name(s): Rompun®, AnaSed®, Gemini®, Xylamav®, Thiazine® (xylazine); Dormosedan®, Domosedan® (detomidine); Zalopine®, Domitor® (medetomidine).

Mechanism of Action: Act on pre- and postsynaptic alpha$_2$-adrenergic receptors in central and peripheral nervous system to inhibit release of norepinephrine.

Clearance: Metabolized in the liver and excreted in urine.

Routes of Administration: IM, SC.

Advantages: Potent sedation.

- Good muscle relaxation.
- Analgesic.
- Can be completely antagonized.
- Compatible with and potentiates other immobilizing agents.

Disadvantages: Respiratory depressants, particularly when used with other drugs having similar properties.

- Cause hypotension and bradycardia.
- Prolonged effect if not antagonized.
- Can cause ataxia if not antagonized in some species (e.g., pronghorn).
- Cause hyperglycemia and glucosuria (probably not clinically significant).
- Disrupts thermoregulatory capabilities.
- Causes vomiting in canids and felids.
- Decreases gastrointestinal motility, particularly in ruminants.

Antagonists: Yohimbine, tolazoline, idazoxan, atipamezole.

Formulation: Xylazine: 20 or 100 mg/ml solution; can be lyophylized and reconstituted up to 500 mg/ml.

- Detomidine: 10 mg/ml solution.
- Medetomidine: 1 and 10 mg/ml solution.

Comments: Not controlled substances. Immobilization or sedation of highly excited animals using alpha-adrenergic agonists alone will be prolonged, if not impossible (Jacobsen, 1983). If a sedated animal is aroused, eliminating the stimulation will usually result in resedation and/or recumbency. Detomidine and medetomidine are much more potent than xylazine and more selective for specific alpha$_2$-adrenergic receptors. Although no direct studies have been done, detomidine is approximately 10 times more potent than xylazine and medetomidine is from 40-200 times more potent than xylazine.

General Anesthetics

Barbiturates

Although barbiturates have been successfully used to immobilize a variety of wild animals, their use has diminished in recent years due to more efficacious and safer drugs. The barbiturates are classified as sedative-hypnotic drugs, but they produce a variety of physiological effects. Depending on chemical substitution of the barbituric acid molecule, the barbiturates may have a long (phenobarbital, barbital), intermediate (amobarbital), short (pentobarbital, secobarbital), or ultrashort (thiamylal, thiopental, methohexital) duration of effect. Barbiturates act throughout the CNS, with the mesencephalic reticular activating system being exquisitely sensitive to the drug. Their site of action can be either presynaptic (cortex, cerebellum, thalamus) or postsynaptic (spinal cord).

Barbiturates act as major respiratory depressants by suppressing the neurogenic drive as well as the hypoxic and chemoreceptor drives. They do not have a major cardiovascular effect other than a fall in blood pressure seen with intravenous administration or high doses. Intravenous administration may also cause cardiac arrhythmias.

A major effect of barbiturate use is their interference with the hepatic cytochrome P-450 system. The barbiturates competitively interfere with the biotransformation of a number of enzyme substrates, including other drugs or steroids. Thus, adverse drug reactions or endocrine imbalances may result from use of these drugs.

Phenobarbital, Pentobarbital, Thiopental, Thiamylal, Methohexital

Trade Name(s): Luminal® (phenobarbital); Nemubutal® (pentobarbital); Pentothal®, Intraval® (thiopental); Surital® (thiamylal); Brevane® (methohexital).
Mechanism of Action: Polysynaptic suppression; facilitation of GABA-ergic inhibition; GABA-mimetic action.
Clearance: Renal excretion and/or hepatic oxidation.
Routes of Administration: PO, IV, IM, IP (thiobarbiturates cannot be given IM because of tissue damage).
Advantages: Produce range of control from sedation to general anesthesia.

- Length of effect can be modulated based on agent used (long 8-12 hr), intermediate (2–6 hr), short (45–90 min), ultrashort (5–15 min).
- Thiobarbiturates are useful for quickly (20–60 sec) inducing general anesthesia which is subsequently maintained by other agents (i.e., gas anesthesia).

Disadvantages: Generally require large volumes for IM immobilization.

- Major respiratory depressant; also can inhibit fetal respiration without producing anesthesia in mother.
- Can cause laryngospasm, coughing, and sneezing.
- Poor analgesics.
- Poor muscle relaxation.

- Thiobarbiturates given as bolus IV injection or in large doses can cause arrhythmias or cardiac arrest.
- Can cause hyperglycemia, adverse drug interactions, or endocrine alterations.

Antagonists: None.

Formulation: Several solutions or powders available; adjust concentration to needs.

Comments: Controlled substances (Schedules II, III). Compared to other immobilizing agents, the barbiturates are generally unsatisfactory for free-ranging wildlife immobilization. Their primary use in veterinary medicine today is to rapidly induce anesthesia which is maintained by inhalation anesthetics. A similar use is appropriate for small, manually-restrained wild mammals or birds. Oral barbiturates in bait have been used successfully to capture waterfowl and gamebirds.

Cyclohexanes

Also termed dissociative anesthetics, this group of drugs (ketamine, tiletamine, phencyclidine), cause a functional and electrophysiological dissociation between the thalamoneocortical and limbic systems. They are characterized by producing a cataleptic state (a malleable rigidity of the limbs) in which the eyes remain open with intact corneal and light reflexes. Ketamine is probably one of the most widely used drugs for wildlife immobilization because of its efficacy and high therapeutic index. It is generally used on small- and medium-sized mammals, but can immobilize species ranging from reptiles to large ungulates. Phencyclidine is the most potent of these drugs, but is no longer available in the U.S. because of abuse by humans. Tiletamine is unavailable as a single product and it is combined in equal proportions with the diazepinone tranquilizer, zolazepam. When used alone, tiletamine produces convulsive seizures and clonic muscular reactions while zolazepam alone causes aggressive behavior (in domestic cats). Combining these two drugs (e.g., Telazol®, Zoletil®) results in fewer convulsions, good muscle relaxation and smoother recoveries. Telazol® (previously identified as CI-744) is currently approved only for use in dogs and cats, but during its development, it was used on over 200 non-domestic vertebrate species (Gray et al., 1974; Boever et al., 1977b; Schobert, 1987). The relative potencies of phencyclidine, tiletamine, and ketamine is approximately 5 : 2.5 : 1, respectively (Beck, 1972).

When used singly, the cyclohexanes usually cause rough inductions and recoveries, and convulsions are not uncommon. Because of this, they are usually administered concurrently with tranquilizers or sedatives. The cyclohexanes are also thought to have amnestic properties, that is, humans (and presumably animals) have little or no recollection of the anesthetic event. There is no complete antagonist of the cyclohexanes, although several drugs appear to antagonize some of their effects. Physostigmine, neostigmine, L-amphetamine, 4-aminopyridine, yohimbine, tolazoline, and naloxone may have partial antagonistic properties (Kreeger and Seal, 1986a).

Ketamine, Tiletamine, Phencyclidine

Trade Name(s): Ketaset®, Vetalar®, Ketalean® (ketamine); Telazol®, Zoletil® (tiletamine/zolazepam); Sernylan® (phencyclidine).

Mechanism of Action: Unknown, presumably a complex involving sigma, cholinergic, serotonergic, dopaminergic, and N-methylaspartic receptors.

Clearance: Metabolized in the liver by N-demethylation via cytochrome P-450 enzymes, conjugated to water-soluble glucuronide derivatives, and excreted in urine.

Routes of Administration: IM, IV, SC, IP, PO.

Advantages: Effective on many species.

- Safe (high therapeutic index).
- Provide peripheral analgesia (visceral pain not abolished).
- Minimal respiratory effects (depressant only at high doses).
- Good cardiovascular support (heart rate and blood pressure increase).

Disadvantages: Rough inductions and recoveries when used without tranquilizers.

- Poor muscle relaxation when used without tranquilizers.
- Convulsant, particularly with prolonged administration or high doses (ketamine, phencyclidine).
- Can cause copious salivation.
- Produce a variety of hematologic, serum chemical, and endocrine alterations.

Antagonists: No complete antagonist (see above).

Formulation: Ketamine: 100 mg/ml (can be lyophilized and reconstituted up to 200 mg/ml).

- Tiletamine: 250 mg tiletamine + 250 mg zolazepam per vial (can be reconstituted up to 250 mg/ml each).
- Phencyclidine: 20 and 100 mg/ml.

Comments: Phencyclidine (Schedule II) and Telazol® (Schedule III) are both controlled substances; currently ketamine is not controlled. The eyelids normally remain open during cyclohexane anesthesia and the eyes of animals immobilized outdoors should be protected from drying out and from ultraviolet light. Palpebral and corneal reflexes usually remain intact under cyclohexane anesthesia and shouldn't be used to assess depth of anesthesia. Remember that tiletamine is available only with an equal weight of zolazepam. The vial is marked 100 mg/ml Telazol®; adding 5 ml of diluent to the vial provides a 100 mg/ml solution containing 50 mg tiletamine and 50 mg zolazepam. If profound salivation is problematic, it can usually be controlled with atropine (see *Adjuvants*). However, it should be remembered that both cyclohexanes and atropine increase heart rate; the combination of these two drugs may produce unacceptably high heart rates. A tranquilizer/sedative should be used in almost all cases with the cyclohexanes to reduce or prevent the untoward effects of these drugs.

Opioids

Opium is a drug obtained from the juice of the poppy, *Papaver somniferum*, and contains over 20 alkaloids. Opioid immobilizing agents are generally congeners of two of these alkaloids, morphine and thebaine. The opioids have been used for animal immobilization since the 1960s and are the most potent drugs available for this purpose. The three most commonly used opioids are fentanyl, etorphine, and carfentanil. Fentanyl is a congener of meperidine, a synthetic opioid; etorphine is an analog of thebaine; and carfentanil is a derivative of fentanyl. In rats, fentanyl is approximately 100 times more potent; etorphine 1,000 times more potent (Dobbs, 1968); and carfentanil 9,400 times more potent (Marsboom, 1985) than morphine. In humans, etorphine is 500 times more potent than morphine (Jasinski et al., 1975). De Vos (1978a) estimated the ratio of effect of carfentanil : etorphine : fentanyl as 20 : 15 : 1.

Sufentanil is another fentanyl congener used primarily in human medicine, but it can be used on wild animals (Kreeger and Seal, 1990). Sufentanil is 4,500 times more potent than morphine and it has a safety margin 2.5 times that of carfentanil (Marsboom, 1985).

A3080 is a new synthetic opioid not yet on the market. In elk, A3080 appeared to give rapid induction with a shorter duration of action than carfentanil which may be beneficial in reducing renarcotization (Stanley et al., 1988; Janssen et al., 1991). The potency of A3080 appears to be somewhat less than carfentanil (Lance, 1991), but more than etorphine.

Butorphanol is a morphinan analogue with a potency 3.5–7 times that of morphine. Butorphanol has mixed agonist-antagonist properties. Higher doses (> 0.5 mg/kg) of butorphanol may result in no effect as antagonistic properties tend to dominate. The antagonist potency is about 1/40 that of naloxone, nonetheless high doses can be used to antagonize other opioids. Alone, butorphanol provides only "apathetic sedation." When combined with xylazine, butorphanol is capable of immobilizing small- to medium-sized animals up to 50 kg (Kreeger et al., 1989a).

The opioids interact with stereospecific and saturable receptors in the CNS. Several opioid receptors have been identified (kappa, delta, mu) which bind natural and synthetic exogenous opioids as well as endogenous opioids (endorphins, enkephalins, dynorphins). Most opioid drugs appear to act preferentially at mu receptors. Opioids either selectively inhibit the release of excitatory neurotransmitters (i.e., dopamine) or act at postsynaptic sites. A major advantage in the use of opioids is the availability of specific antagonists. Some agents (e.g., butorphanol) are classified as agonist-antagonists and possess both properties depending upon the dose and affected receptor population.

A phenomenon seen with the use of opioids for animal immobilization is "recy-

cling" or "renarcotization." After antagonism, the animal appears to again come under the influence of the opioid agonist. This can occur relatively quickly or several hours to days after the immobilizing episode. Recycling appears to occur more frequently, but not exclusively, with carfentanil use (Jessup et al., 1984a; Jessup et al., 1985b; Seal et al., 1985b; Kreeger and Seal, 1990). Recycling may be due to the more potent agonists being metabolized slower than the antagonist or to their marked lipophilia resulting in prolonged release from fat depots.

The potency of opioids, such as etorphine and carfentanil, is both an advantage and disadvantage. The advantage is the reduced volume of drug required for immobilization makes them the only class of drugs capable of remote immobilization of large animals. The disadvantage is that they are potentially toxic to humans. The lethal human dose of opioids is unknown, but presumably small (Carpenter and Lance, 1983; Hess et al., 1987). Extra care should be the rule of the day when working with this drug class. Toxic exposure can be by accidental injection with a syringe or dart, by absorption through the mucous membranes of the mouth, eyes, or nose, or by direct absorption through broken skin. Death is almost always due to respiratory failure. Opioid immobilizing agents should never be used while working alone or without having an antagonist immediately on hand. If you are exposed to these opioids without the availability of an antagonist, by yourself, or even with someone who is ignorant of CPR (cardiopulmonary resuscitation), there is a strong possibility that you will not survive. Anyone using these agents should read the sections on antagonists and on *Emergency Treatment - Human* for appropriate responses to opioid overdose.

Fentanyl, Sufentanil, Carfentanil, Etorphine, A3080

Trade Names: Innovar-Vet®, Fentaz®, Fentazin®, Immobyl®, Sublimaze®, (fentanyl); Wildnil® (carfentanil); M99®, Large and Small Animal Immobilon® (etorphine).

Mechanism of Action: Interact with stereospecific and saturable opioid receptors in the CNS.

Clearance: Metabolized in the liver by glucuronic conjugation or by N-demethylation and excreted in bile or by the kidneys.

Routes of Administration: IM, IV, SC, PO.

Advantages: Potency allows volumes suitable for immobilization of the largest of animals.

- Rapidly antagonized.
- Analgesic.
- No major cardiovascular effects.

Disadvantages: Potentially toxic to humans at low doses.

- Major respiratory depressants.
- Can "recycle" after antagonism.
- Can cause prolonged, excitatory state prior to induction.
- Alter thermoregulation.

- Do not interfere with senses of touch, vibration, vision, or hearing (animal responds to such stimulation).
- Poor muscle relaxation in some species (ungulates, equids).
- Increases salivation.
- May cause vomition and defecation.
- May induce temporary endocrine changes.

Antagonists: Diprenorphine (M50-50®), naloxone, naltrexone, nalmefene.

Formulation: Wildnil®: 3 mg carfentanil/ml solution.

- M99®: 1, 4.9, or 9.8 mg etorphine/ml solution.
- Innovar-Vet®: 0.4 mg/ml fentanyl + 20 mg/ml droperidol solution.
- Fentaz®: 10 mg/ml fentanyl + 80 mg/ml azaperone solution.
- Sufenta®: 50 µg/ml solution.
- Large Animal Immobilon®: 2.45 mg/ml etorphine + 10 mg/ml acepromazine solution.
- Small Animal Immobilon®: 0.07 mg/ml etorphine + 18 mg/ml methotrimeprazine solution.

Comments: Controlled substances (Schedule II). Felids and equids should not be given opioids without tranquilizers/sedatives to avoid excitation upon induction. In general, concurrent use of tranquilizers in all species hastens and smoothes induction as well as ameliorates many of the adverse effects of opioids. However, tranquilizers having adverse effects such as respiratory depression or thermoregulation alteration may exacerbate these conditions when used with opioids.

Butorphanol

Trade Name(s): Torbutrol®, Torbugesic®, Stadol®.

Mechanism of Action: Kappa opioid receptor agonist; mu receptor antagonist.

Clearance: Metabolized in the liver and excreted by the kidneys.

Routes of Administration: IM, IV.

Advantages: Safe, high therapeutic index.

- Minimal cardiovascular and respiratory effects.
- Can be antagonized.
- Good analgesic.

Disadvantages: Provides only mild sedation when used alone.

- Limited to calm or restrained animals.

Antagonists: Naloxone, naltrexone, nalmefene.

Formulation: 0.5, 1, 10 mg/ml solutions; 1, 5, 10 mg tablets.

Comments: Not a controlled substance. Can be combined with xylazine to provide profound sedation to anesthesia (Kreeger et al., 1989a). This combination is best limited to immobilization of calm or restrained animals. Such immobilized animals also tend to be more stimulated by sound or touch than other drug combinations. This combination does have the advantage of being completely and quickly antagonized with opioid and alpha$_2$-adrenergic (yohimbine, idazoxan, atipamezole) antagonists.

Steroid Anesthetics

Steroid anesthetics have been known since the 1940s, but they have found only limited use in wildlife immobilization. They have been used on reptiles (Calderwood and Jacobson, 1979b), birds (Cooper and Frank, 1973), raccoons (Clutton and Duggan, 1986), and cheetahs (Button et al., 1981). The only currently-available product (althesin; Saffan®) is a mixture of two pregnanediones, alphaxalone and alphadolone acetate, in a solution of saline and polyoxyethylated castor oil. Althesin induces a short-acting (5–10 min), dose-dependent anesthesia with good muscle relaxation. Althesin can be administered either IV or IM, but volumes tend to be high when used on larger animals. It can be used in combination with most gas anesthetics and neuromuscular blockers, but it cannot be used with barbiturates. Althesin has been approved for use on humans in Canada and the U.K., but has not been approved for use in the U.S.

Althesin

Trade Name(s): Saffan®.

Mechanism of Action: Unknown.

Clearance: Biotransformation in the liver to polar metabolites and excreted in the bile.

Routes of Administration: IM, IV.

Advantages: Produces general anesthesia of short duration.

- Wide safety margin.
- Minimal respiratory depression.
- Good muscle relaxation.

Disadvantages: Large volumes required.

- Can cause histamine release (see comments).
- Recovery can be rough.
- Can cause necrotic lesions in the extremities in cats (rare).

Antagonists: None.

Formulation: 12 mg/ml solution comprised of 9 mg/ml alphaxalone and 3 mg/ml alphadolone.

Comments: Althesin is contraindicated for use in domestic dogs (and presumably wild canids) because the polyoxyethylated castor oil can cause release of histamine resulting in cardiovascular collapse. If given IV, althesin should be given slowly in all species. Also, althesin cannot be used with barbiturates.

Propofol

Propofol (Diprivan®) is an injectable anesthetic chemically unrelated to other intravenous anesthetics. The compound comes as an 1% (10 mg/ml) emulsion in oil. It has a milky appearance and it is easily contaminated with bacteria and mold unless strict sterile withdrawal technique is observed. Propofol when given IV in a rapid bolus (6.6 mg/kg) produces general anesthesia of short duration (Mandelker, 1993). Following induction, respiration is often depressed, sometimes to the point

of apnea, but this effect lasts only for approximately 30 seconds. Due to its rapid elimination, recovery from propofol can lead to disorientation and paddling of the limbs. The addition of diazepam (0.4 mg/kg) is often helpful in providing muscle relaxation and smoothing recovery. Low doses of acepromazine (0.1 mg/kg) given as a preanesthetic can lower the propofol dose by one-half (Mandelker, 1993). Propofol can be used like the barbiturates to induce anesthesia that will be maintained by gas. Propofol has found some limited use in wild ruminants and camelids (Jalanka and Teräväinen, 1992), but for the time, its use appears restricted to small animals that can be safely restrained. Propofol is not yet approved for use in the U.S.

Inhalation Anesthetics

Inhalation (gas) anesthetics are not commonly used for free-ranging wild animal restraint. As sole induction agents they are limited to either young animals or species small enough to be manually restrained or enclosed in a container. Their major use is in zoo veterinary medicine to maintain anesthesia after the animal has been immobilized with an injectable agent. Inhalation anesthetics offer good control over the depth and duration of anesthesia because they follow the dose-response concept (i.e., the effect increases as the dose increases; Sedgwick, 1986b). Thus, inhalation anesthetics are more predictable than injectable agents. Inhalation anesthetics induce anesthesia by depressing CNS function and they may change other organ physiology as well.

Gas delivery systems can be as simple as a container with ether-soaked cotton to a multiple-vaporizer gas anesthetic machine. To fully use the control advantages offered by inhalation anesthetics, precision-calibrated vaporizers should be employed. Portable machines with such vaporizers have been developed (Anesta-Pac, Inc., Chesterfield, Missouri). Also, component parts can be purchased separately, enabling the construction of a custom gas anesthetic delivery system. An open delivery system can be constructed from just an oxygen tank, regulator, vaporizer, and tubing such as an Ayre's "T" piece or Bain circuit. Inhalation anesthetic metabolites can be toxic to the kidneys (nephrotoxic) or liver (hepatotoxic). Thus, repeated exposure to these agents through the use of open systems should be minimized.

A comprehensive discussion of the physics and physiology of inhalation anesthetics is beyond the scope of this manual. Inexperienced individuals considering the use of such anesthetics should consult anesthesiologists and textbooks. Following is a brief description of the common inhalation anesthetics:

Chloroform

This is an obsolete agent that has been replaced by safer and more effective compounds. Chloroform is both hepatotoxic and nephrotoxic.

Diethyl Ether

Ether is a versatile anesthetic that can be administered with the simplest of equipment. It is little used today, however, because of its high inflammability (it forms an explosive mixture with air or oxygen). It is a potent analgesic and good muscle relaxant, producing gradual suppression of reflexes. Induction and recovery are relatively slow. Ether irritates the respiratory passages, producing salivation and tracheal and bronchial secretions. Cardiac output is unaltered or slightly increased; arrhythmias are rare. Nausea and vomiting may occur during induction. Ether is neither hepatotoxic or nephrotoxic. It causes hyperglycemia as a result of mobilization of liver glycogen, as well as increasing levels of antidiuretic hormone, hydrocortisone, thyroxine, and norepinephrine. The majority of ether (85-90%) is eliminated through the lungs, with the remainder lost through the skin, mucous membranes, and liver biodegradation.

Nitrous Oxide

This is used primarily as an adjunct to other gas anesthetics. By itself, it produces only mild anesthesia and analgesia. When combined with a more potent gas, nitrous oxide decreases the amount of gas required for complete anesthesia. Nitrous oxide does not appear to have deleterious effects on the liver, kidneys, or gastrointestinal tract. Nitrous oxide should be used with a minimum of 30% oxygen in the total gas flow to prevent hypoxia.

Halothane

The predecessor of most of the inhalation anesthetics used today, halothane is a potent anesthetic, producing a rapid and smooth loss of consciousness. Halothane produces a hypotension related to the depth of anesthesia. It directly causes vasodilation and decreases cardiac output. Thus, monitoring arterial blood pressure provides the best information about the depth of anesthesia. Halothane also depresses respiration at all levels of anesthesia, decreases gut motility, depresses temperature regulating centers, and only moderately relaxes muscles. Although it is not nephrotoxic, "halothane hepatitis" occurs in 1 out of 10,000 uses in humans. The incidence of such hepatotoxicity in other species is unknown. The majority of halothane is eliminated unchanged in exhaled gas. The remainder undergoes either biotransformation or elimination unchanged by other routes.

Enflurane

Enflurane provides a smooth and fairly rapid induction and emergence from anesthesia. Depth of anesthesia can be adjusted relatively quickly. Enflurane decreases blood pressure to about the same degree as halothane, but bradycardia and arrhythmias are lessened. Enflurane provides good muscle relaxation and analgesia, but depresses respiration as its concentration increases. It is not nephrotoxic, but hepatic necrosis has been reported associated with repeated administration. The majority of enflurane is expired, with small amounts being biotransformed. Tranquilizers should be used to smooth induction and to avoid emergence delirium.

Isoflurane

This is an isomer of enflurane that provides rapid and smooth induction and emergence from general anesthesia. Anesthetic depth can be changed more rapidly than with other gases. Blood pressure decreases progressively with increasing depth of anesthesia as a result of decreased vascular resistance. However, cardiac output is maintained because of increased heart rate. Arrhythmias are rare, except perhaps in birds. Isoflurane causes a more profound respiratory depression than either halothane or enflurane. It is an excellent muscle relaxant and is neither nephrotoxic nor hepatotoxic. Only a fraction of isoflurane is metabolized. Isoflurane is an excellent inhalation anesthetic when used with a calibrated vaporizer, but its cost may be prohibitive for casual uses.

Methoxyflurane

Although methoxyflurane is the most potent of the gas anesthetics, induction is slow because of its low vapor pressure. An injectable agent usually is used to induce anesthesia, which can then be maintained by methoxyflurane. Changes in anesthetic depth are likewise slow, but overdosage is less likely than with the other anesthetics. Methoxyflurane provides good muscle relaxation and analgesia while depressing respiration and cardiovascular function. It has caused renal failure in humans, which has led to a decrease in its use. Such renal failure in other species has not been reported. Up to 50% of the absorbed gas is metabolized in the liver. Methoxyflurane can be administered via a vaporizer or simple wick, but the slow induction may cause excitement.

Antagonists

Some of the more notable pharmacological developments relative to wild animal immobilization have been specific, long-lasting opioid and alpha$_2$-adrenergic antagonists. The ability to antagonize anesthesia and return the animal more quickly to physiological normalcy offers many advantages including:

- Alleviation of problems associated with prolonged recumbency such as nerve and muscle damage, bloat, and hypothermia.
- Reduced probability of injury or death after recovery due to accident or predation because there is no residual impairment from the immobilizing drugs such as sedation or ataxia.
- Decreased probability of rejection or interspecific strife due to quicker return to parent, herd, pack, etc.
- Decreased personnel and equipment time dedicated to monitoring the recovery process.

In general, opioid and alpha$_2$-adrenergic antagonists are safe, causing adverse effects only at higher doses. It should be remembered that antagonists act on the animal and not on the agonist. Thus, it does not necessarily follow that the more

potent the agonist, the more amount of antagonist needs to be administered. Increasing the dose of an antagonist usually does *not* decrease recovery times (Kreeger et al., 1987a), but higher doses could prolong antagonism by maintaining serum concentrations at higher levels. When given a choice, one should select an antagonist that is the most specific for the receptors affected and has the longest biological life in the animal.

The preferred route of administration for either the opioid or alpha$_2$-adrenergic antagonists is IV which provides the most rapid recovery. A slower (app. 10-15 min) recovery occurs with IM injection (Wallingford et al., 1996). A common practice is to give equal doses of the antagonist both IV and IM or SC. The IM or SC dose theoretically provides a slower release and thus a longer period for the antagonist to prevent recycling of the agonist. This procedure is routine when atipamezole is given to animals sedated with medetomidine.

Opioid Antagonists

Opioid antagonists have been in use for over 40 years and their use in combination with potent opioid agonists made them powerful tools for wildlife immobilization. Today, they are used extensively to antagonize the effects of such opioid agonists as fentanyl, etorphine, and carfentanil. Early antagonists included nalorphine, levallorphan, pentazocine, nalbuphine, and diprenorphine. Some of these antagonists (diprenorphine, nalorphine, levallorphan) act antagonistically at the mu receptor while exhibiting agonistic properties at the two remaining opiate receptor sites. Thus, at higher doses, they cause agonistic effects such as respiratory depression. Naloxone, nalmefene, and naltrexone are termed pure antagonists because they exhibit only antagonistic properties at all three opioid receptors.

Naloxone is a synthetic compound of oxymorphone, a thebaine derivative. Naloxone acts by displacing opioid agonists at the receptor because it binds to the receptor with greater affinity without causing activation (Bryson, 1989). However, because the duration of action of naloxone is generally shorter ($T_{1/2}$ = 30–40 min) than the opioid agonists, the opioid effects may recur as the naloxone wear off (Ngai et al., 1976).

Nalmefene is structurally similar to naloxone and it has a high therapeutic index (5,000). Depending on the species, nalmefene is from 16–28 times more potent and has a much longer duration of action than naloxone (Dixon et al., 1986). Although nalmefene has been used as an opioid antagonist in wildlife (Kreeger et al., 1987b) and is a superior antagonist relative to naloxone, its use will probably be limited because of the development of an even better antagonist, naltrexone.

Naltrexone is a synthetic structural analog of thebaine. Naltrexone appears to have an antagonistic activity 2–9 times greater than that of naloxone (Bryson, 1989). Besides being more potent, naltrexone has a much longer duration of ac-

tion than naloxone and therein lies its advantage for wildlife use. The reason for this is that naltrexone, like naloxone, undergoes extensive first pass hepatic metabolism, but whereas naloxone's metabolites have little or no antagonistic properties, naltrexone's major metabolite, 6-β-naltrexol, is also a pure antagonist and contributes to opioid receptor blockade. The half-lives ($T_{1/2}$) of naltrexone and 6-β-naltrexol are 4 hours and 13 hours, respectively. An example of the significance of this is that 50 mg of naltrexone will block the pharmacological effects of morphine in humans for up to 24 hours; doubling the dose of naltrexone provides blockade for 48 hours; and tripling the dose provides blockade for about 72 hours (Bryson, 1989). Thus high doses of naltrexone have been shown to be the most effective tool in not only antagonizing the effects of the potent opioid, carfentanil, but also in having the capability of reducing or preventing recycling or renarcotization (Schmitt and Dalton, 1987; Haigh, 1991). Pure opioid antagonists also have advantages over other antagonists such as diprenorphine, nalorphine, and levallorphan in that they have high therapeutic indexes and they are the antagonists of choice for accidental human exposure to the opioid agonists (see *Emergency Treatment - Human*).

An advantage of the less-potent opioid antagonists, such as nalbuphine, is that it can be used to only partially antagonize the opioid effect. Thus, a dose-dependent, graded reversal of opioid anesthesia can be achieved. This has been found useful in Africa for the capture and transport of large, difficult animals like the rhinoceros. Rhinos are initially immobilized with etorphine and their head and legs secured with ropes. Nalbuphine is then administered at low doses to achieve partial recovery. The rhino becomes ambulatory but somewhat stupefied and seemingly unaware of people or circumstances. It can then be guided or "walked" by the handlers into a transport crate on a truck. The animal is often given no more antagonist so that it can complete the journey in what is equivalent to a tranquilized state (Kock, pers. comm.).

Diprenorphine, Levallorphan, Naloxone, Naltrexone, Nalmefene

Trade Name(s): M50-50®, Revivon® (diprenorphine); Lorfan® (levallorphan); Narcan® (naloxone); Trexan® (naltrexone).

Mechanism of Action: Competitive opioid antagonists at receptors on synaptic membranes of the amygdala, hypothalamus, and thalamus; primarily act at mu receptors, but may have kappa- and delta-opioid receptor activities.

Clearance: Metabolized by the liver and excreted.

Routes of Administration: IV, IM, SC.

Advantages: Provide rapid and complete opioid antagonism.

- Safe, generally have high therapeutic indices.
- Can be prepared in high concentrations having long shelf life.
- May be used to attenuate hypotensive shock (not diprenorphine).

Disadvantages: At high doses can cause excitement, incoordination, vomiting, respiratory depression.

- May affect endocrine systems temporarily.

Formulation: Diprenorphine: 2 mg/ml solution (M50-50®); 3 mg/ml (Revivon®).

- Levallorphan: 1 mg/ml solution.
- Naloxone: 0.02 or 0.4 mg/ml solution.
- Naltrexone: 50 mg/ml solution.

Comments: Only diprenorphine is a controlled substance (Schedule II). Naloxone, naltrexone, or nalmefene are preferred over diprenorphine. Also, these three antagonists are the only ones suitable for human opioid overdose since they do not possess any opioid agonistic properties.

Alpha-adrenergic Antagonists

Alpha-adrenergic antagonists are used to antagonize tranquilizers such as xylazine, detomidine, and medetomidine. The 1980s saw an explosion of scientific reports when yohimbine, a long-known plant alkaloid, and tolazoline were "rediscovered" as antagonists to xylazine used primarily in the immobilization of ungulates (Jessup et al., 1983; Hsu and Shulaw, 1984; Jacobsen and Kollias, 1984; Allen 1986a; 1986b; Kreeger et al., 1986a), but also of carnivores (Kreeger et al., 1987a). Neither yohimbine nor tolazoline are specific adrenergic antagonists. In addition to adrenergic activity, yohimbine may also have cholinergic, serotonergic, and dopaminergic receptor activity and tolazoline has histaminergic activity. Because of this broad activity, these agents may cause undesirable side effects.

Early on, many investigators claimed that yohimbine could antagonize ketamine-xylazine anesthesia. However, yohimbine primarily antagonizes only the xylazine component of this combination. Carnivores immobilized with ketamine-xylazine appear to have a residual ketamine effect after yohimbine administration (Kreeger and Seal, 1986b) and yohimbine failed to completely antagonize ketamine-only immobilization of rhesus monkeys (Lynch and Line, 1985) and gray wolves (Kreeger and Seal, 1986b). Because yohimbine does not fully antagonize ketamine, it should not be administered in animals anesthetized with xylazine-ketamine combinations until *at least 30 minutes* have elapsed since the *last ketamine* injection. This is to allow further metabolism of the ketamine component of the combination. If yohimbine (or any adrenergic antagonist) is given when ketamine serum concentrations are still high, the xylazine component will be antagonized resulting in an anesthetic recovery from what is essentially pure ketamine. Such recoveries are characterized by uncontrolled, often violent, body movements and/or severe hyperthermia which can cause injury or death to the animal (Kreeger et al., 1990a).

Although effective, both yohimbine and tolazoline will probably be replaced by newer, more specific antagonists. Two of the newer antagonists are idazoxan and atipamezole. Atipamezole is more potent and more selective than either yohimbine or idazoxan. For example, the alpha$_2$/alpha$_1$ selectivity ratio for atipamezole is 8,526 compared to 27 for idazoxan and 40 for yohimbine. Atipamezole effectively antagonizes the behavioral, cardiovascular, gastrointestinal, neurochemical,

and hypothermic effects of medetomidine (Virtanen and MacDonald, 1987). Neither idazoxan nor atipamezole are available in the U.S. as of this writing, but atipamezole is currently undergoing the approval process. It does not appear that idazoxan will be approved for use in the U.S., mainly because atipamezole is a superior antagonist and pharmaceutical firms have abandoned idazoxan in favor of atipamezole. Idazoxan is available in Canada, however.

Although both idazoxan and atipamezole are used for the antagonism of xylazine, detomidine, and medetomidine, only atipamezole should be used to antagonize the effects of medetomidine because medetomidine is a more potent and specific agonist and yohimbine or idazoxan may result in incomplete antagonism.

Idazoxan has been used to antagonize the effects of xylazine in zoo animals at doses ranging from 0.034–0.25 mg/kg, depending on the species (Crawshaw et al., 1986; Kock et al., 1989). Atipamezole has been used to antagonize the effects of medetomidine in dozens of species and it is generally administered at a dose 5 times higher than medetomidine on weight/weight basis. For example, if medetomidine was given at a dose of 0.01 mg/kg, atipamezole would be given at 0.05 mg/kg. This ratio holds even if medetomidine is used in conjunction with another drug, such as ketamine (with the exception of carnivores given medetomidine/ketamine, then the atipamezole/medetomidine ratio can be reduced to as low as 3). Often, the total dose is split with one-half administered IV and the other half given either IM or SC. Atipamezole effectively antagonizes xylazine at a ratio of 1 mg atipamezole for every 10 mg xylazine used (Jalanka and Roeken, 1990).

Yohimbine, Tolazoline, Idazoxan, Atipamezole

Trade Name(s): Antagonil®, Yobine® (yohimbine); Priscoline®, Tolazine™ (tolazoline); Aterprin®, Antisedan® (atipamezole).

Mechanism of Action: Displaces adrenergic agonists on pre-synaptic alpha2-adrenergic receptors to allow the release of norepinephrine.

Clearance: Excreted unchanged by the kidneys.

Routes of Administration: IV, IM, SC.

Advantages: Antagonizes effects of alpha2-adrenergic agonists such as xylazine, detomidine, and medetomidine.

- Minimal agonist recycling after their use.

Disadvantages: May be more effective in some species than others.

- High doses may cause tachycardia, hypo- or hypertension, anxiety, tremors, or convulsions.

Formulation: Yohimbine: 3 and 5 mg/ml solutions.

- Tolazoline: 25 and 100 mg/ml solution.
- Atipamezole: 5 mg/ml solution.

Comments: Not controlled substances. High doses (> 0.15 mg/kg) of yohimbine in animals given ketamine may result in an extreme tachycardia and hypotension

due to the synergistic cardioacceleratory properties of both drugs. Tolazoline is also a histaminergic agonist which could result in tachycardia, defecation, vomition, salivation, and edema. Tolazoline appears to provide more consistent antagonism of xylazine sedation than yohimbine in sheep and other ruminants. Bovids in particular do not appear to respond reliably to yohimbine (Klein and Klide, 1989). When using drug combinations consisting of a cyclohexane plus an alpha2-adrenergic agonist, do not administer the alpha2-adrenergic antagonist for at least *30 min after* the last dose of the cyclohexane was given. This is to minimize the residual effects of the cyclohexane which is not affected by the antagonist. Waiting to administer the antagonist hastens and smoothes the recovery process. When cyclohexanes are used, do not expect the animal to quickly return to normal after the alpha2-adrenergic antagonist was given as the animal will usually be ataxic for some time (up to 30 min) due to residual effects of the cyclohexane.

Non-specific Antagonists

There are two drugs that appear to have some antagonist action against some anesthetics. They are not pure antagonists in that they do not operate on the same receptors as do the agonists. Nonetheless, upon administration a heightened level of arousal is often noted. Although incapable of effecting complete recovery in the anesthetized animal, their use can help diminish some adverse effects of the anesthetic by increasing respiration or cardiovascular function.

4-aminopyridine has been used to antagonize a variety of chemical immobilizing agents. It can be used alone or as an adjunct to other antagonists, such as yohimbine. 4-aminopyridine plus yohimbine has been shown to antagonize xylazine immobilization of moose, white-tailed deer, and black-tailed deer (Renecker and Olsen, 1985) as well some domestic species.

Doxapram has been used to "antagonize" xylazine sedation and to shorten barbiturate anesthesia in dogs. Its primary use is to stimulate respiration by affecting the carotid and aortic chemoreceptors and the medullary respiratory centers. It can stimulate respiration for hypoventilation or apnea caused by several injectable anesthetics other than barbiturates including ketamine, ketamine-xylazine, and ketamine-promazine (Kreeger, unpubl. data) and opioids such as carfentanil (Allen et al., 1991).

4-aminopyridine

Mechanism of Action: Antagonizes neuromuscular blockade by increasing release of acetylcholine or other neurotransmitters from presynaptic sites.
Routes of Administration: IV, IM.
Advantages: May partially antagonize effects of alpha2-adrenergic agonists.
Disadvantages: Can cause convulsions, residual sedation and ataxia, muscle tremors and spasms, muscle rigidity, and behavioral alterations.

- Not as efficacious as the more specific alpha$_2$-adrenergic antagonists.

Comments: Because of the specificity, efficacy and fewer side effects of other alpha$_2$-adrenergic antagonists, the use of 4-aminopyridine for the antagonism of alpha$_2$-adrenergic agonists is generally not recommended.

Doxapram

Trade Name(s): Dopram-V®, Dopram®.

Mechanism of Action: Enhances excitation at all levels of cerebrospinal axis.

Routes of Administration: IV.

Advantages: Stimulates respiration depressed by several anesthetics.

- May be used to partially antagonize effects of xylazine or barbiturates.

Disadvantages: Low therapeutic index; convulsant dose is not much higher than dose used to stimulate respiration.

- Subconvulsive overdosing may result in tonic-clonic seizures, tachycardia, arrhythmias, hypertension, coughing, sneezing, vomiting, tremors, muscle rigidity, and hyperpyrexia.

Antagonists: None

Formulation: 20 mg/ml solution.

Comments: Can stimulate respiration for hypoventilation or apnea caused by several injectable anesthetics. The duration of respiratory stimulation is brief (5–10 min); repeated doses may induce convulsions. Maintenance of respiration should always be done by physical means. Convulsions and other overdose effects can be controlled by 5–10 mg diazepam IV.

Adjuvants

Adjuvants are substances added to drugs which affect their action of the active ingredient in a predictable way. They may be added to the immobilizing drug "cocktail" to decrease undesirable effects or to heighten desirable effects. Adjuvants should be used conservatively, however, as they are capable of producing undesirable effects of their own if used incorrectly.

Atropine and hyoscine butylbromide are often used to decrease salivation caused by cyclohexanes or increase heart rate depressed by alpha-adrenergic agonists. Hyoscine butylbromide (scopolamine butylbromide) is used more frequently in Africa where it is used on antelope and rhinoceros. Hyoscine is more potent than atropine and affects the CNS more readily. Although high doses of atropine have a sedative effect, hyoscine produces sedation with less side effects. Hyoscine induces a state of catalepsy, photophobia, and mydriasis which facilitates the loading of rhinos in crates after the immobilizing drug has been antagonized (Swan, 1993).

Hyaluronidase is an enzyme that is sometimes mixed with the immobilizing agent

in order to increase the absorption rate of the drug. It is most often used on large species, such as elephants and rhinos.

Atropine, Hyoscine (Scopolamine)

Trade Name(s): Several trade and generic brands.
Mechanism of Action: Competitive antagonist of acetylcholine.
Clearance: Excreted unchanged in urine.
Routes of Administration: IV, IM.
Advantages: Decreases salivation caused by cyclohexane drugs.

- Inhibits bradycardia caused by alpha2-adrenergic agonists (e.g., xylazine).

Disadvantages: Higher doses cause tachycardia, mydriasis, bronchodilation, reduction of gastric secretion and motility, and death.
Antagonists: Physostigmine (see comments).
Formulation: 0.5, 2, 15 mg/ml solutions.
Comments: Atropine is usually administered as a premedication or immediately following immobilization. The standard dose is 0.04 mg/kg. Atropine and hyoscine use should be carefully justified when used on animals to be released in the wild because these drugs cause prolonged mydriasis (dilation of the pupil) and cycloplegia (paralysis of the pupil) which cause temporary blindness and discomfort. Animals given these drugs should be protected from direct sunlight. Caution should be also used with atropine given to animals immobilized with a cyclohexane–alpha2-agonist mixture (e.g., ketamine-xylazine) then given an alpha2-agonist (e.g., yohimbine). Ketamine, yohimbine, and atropine will all increase heart rate; the synergistic effect of all three drugs may cause extreme tachycardia with a concomitant fall in blood pressure because the heart is beating too rapidly to allow adequate filling and compression (Kreeger et al., 1987a). Physostigmine antagonism should only be used when atropine overdosage is life-threatening or the animal exhibits extreme agitation and is at risk of injuring itself. Give 0.02 mg/kg IV slowly; if no response, repeat dose every 15 min.

Hyaluronidase

Trade Name(s): Hyalase®.
Mechanism of Action: An enzyme that randomly cleaves b-N-acetyl-hexosamine-[1-4] glycosidic bonds in hyaluronic acid, chondroitin, and chondroitin sulfates.
Clearance: Excreted unchanged in urine.
Administration Routes: SC, IM.
Advantages: Increases absorption rate of other drugs.
Disadvantages: Higher doses can cause tissue damage.
Antagonists: None.
Formulation: Several formulations; most are lyophilized powders from bovine or sheep testes. Available in 300–15,000 units/mg.
Comments: Hyaluronidase acts as a spreading agent to promote diffusion. It has been used to increase drug absorption and thus decrease induction time when used with succinylcholine and opioids in species such as white-tailed deer, moose, and

elephants (Morton et al., 1991; Morton and Kock, 1991; Kock et al., 1993). Must be kept refrigerated until ready for use.

The Capture Event

The following four "rules" have been developed through years of experience and they should always be recalled prior to any capture operation.

Most of the effort involved in the handling and treatment of a wild animal will be attributed to the immobilization process.
Until you get some immobilization experience under your belt, you won't believe how much time it takes to locate, get close to, and immobilize a wild animal. Thus, allow plenty of time to both immobilize the animal and monitor its recovery. To accomplish this, most immobilizations should be conducted in the early morning so that you will have ample daylight for the operation.

Always plan ahead and be prepared for any contingency.
Whatever can go wrong, probably will (particularly when someone important is watching!). Most cases of animal loss can be attributed to human error, so think twice and act once. Before you set out to immobilize an animal, take a few minutes and mentally walk through the process. Try to imagine for each step what equipment is required and what can go wrong. Then make sure you have the appropriate supplies, drugs, etc. to respond to each event that you visualized.

An immobilized animal becomes a valuable animal - both intrinsically and economically.
The loss of any animal is regrettable; the loss of an endangered species is tragic. Also, a great deal of personnel and equipment costs are usually invested in an immobilization; thus, care and treatment of the animal should not be trivialized.

Keep records.
Good records are essential references for future immobilizations, research, and analyzing disasters(!). Refer to the sample record presented in Chapter 1.

Considerations Prior to Animal Immobilization

The species, purpose, and circumstances of the immobilization must be considered prior to undertaking the drugging of any animal. Reasons for drugging animals include capture, translocation, sampling, marking, instrumentation, treatment, and removal from a trap. One should ascertain if the immobilization is really necessary and whether the *risk of killing the animal justifies the planned gains*. If committed to the immobilization, there are factors to consider prior to, during, and after the immobilization episode.

Species

Drug choice, drug doses, and animal response change between species and may vary within species. Adhering to an inflexible drugging protocol can easily end in disaster. Know the species in terms of body weight range, basic feeding habits, seasonal reproductive and condition cycles, and response to available drugs. Be prepared to adapt to conditions.

Sex

There is evidence that the sex of the animal can influence drug dose response (Berrie, 1972; King et al., 1977; Kreeger and Seal, 1986b). If this is known for your intended species, be prepared to adjust your doses accordingly.

Age

Younger and older animals usually require less drug per unit body weight than do prime-age adult animals. There is also higher risk of complications developing with these animals.

Weight.

Most current drug dosage literature is based on milligram of drug per kilogram of body weight. Weight estimates accurate to ± 20% are easy to make with experience and doses based on such estimates should be safe. More accurate estimates (± 10%) are necessary when using drugs that have low therapeutic indices. Keeping records of animal weight estimates coupled with actual weights after the animal is captured are useful reference sources.

Season

For certain drugs, such as succinylcholine, the time of year may have a profound effect on the amount of drug required to immobilize an animal. For instance, white-tailed deer require 61% more succinylcholine in fall than during winter (Jacobsen et al., 1976).

Physical Condition

In general, a sick, exhausted, or malnourished animal will usually require less drug than a healthy, well-fed animal. Such compromised animals are high-risk candidates for immobilization.

Psychological Condition

As the excitement level of the animal increases, the chances of a successful immobilization decrease. The calmer the animal, the safer and smoother will be the procedure. An excited animal usually will require a higher drug dose. Failure to consider this phenomenon usually results in underdosing, which leads to even more excitement, increased chances of injury, trauma, hyperthermia, and capture myopathy.

Weather

Adverse weather conditions, ambient temperature, and relative humidity must be considered when immobilizing an animal. During extremes of temperature (below -15 °C/5 °F and above 33 °C/91 °F), equipment or facilities should be available to prevent and treat hypo- or hyperthermia. The physiological effects of the chosen drug on an animal's thermoregulation should be understood so that its response may be anticipated.

Hazards

The physical environment must be considered both before and after the immobilization process. A drugged animal cannot choose where it finally becomes immobilized. Water (including *water bowls*) presents a constant drowning hazard. Falls from rocks, ledges, and steep slopes can injure a semiconscious or ataxic animal. If predation or intraspecific aggression is possible, the animal should be protected or monitored until it recovers.

Drugs

Proper selection of the immobilizing agent is critical. The best drug available that will provide the desired result should be selected. Compared to all other factors, the drug costs are the least significant. If you can't afford the proper drug, then the immobilization probably can't be justified. Remember that immobilization does not always imply a surgical plane of anesthesia. Use of painful or stressful manipulations to an immobilized, but sensory aware, animal is inhumane and unjustified.

Preparation

Have everything that you need with you.

Before you begin the immobilization procedure, be sure that you have all drugs and equipment that you may need. These include additional immobilization drugs and darts should boosters be required (or if you miss with the first dart!), antagonists for both animals and humans in case of accident, monitoring equipment such as stethoscope and thermometer, blindfolds and hobbles, antibiotics, etc. Fishing tackle boxes usually make good receptacles for all this and they come in a variety of sizes and shapes to suit almost all tastes. Vests with multiple pockets, such as a fly fishing or photographer's vest, can be used to carry most items and they free the hands to carry such things as dart guns and pole syringes.

Prepare dart(s) beforehand.
Have one or more darts loaded before you begin your approach. You will usually expend more darts than you would think possible; darts miss, bounce out, fail to discharge, and generally exist to frustrate your life. Be sure that all loaded darts are safely stored so as to prevent accidental injection; plastic test tubes or cigar holders make good holding devices. If you are working in freezing weather, be sure to keep the extra darts warm. It is generally best to load darts under controlled conditions, such as inside a heated building where you can lay everything out and reduce the chance for drug or volume error. Unless absolutely necessary, do not load darts in a moving vehicle. When loading multiple darts, do one step at a time for all darts to avoid mix-ups. For example, during capture operations for the reintroduction of wolves into Yellowstone National Park and Idaho, I would load 15-20 darts by first lubricating and inserting plungers into the dart bodies, then inserting the injection charges, then the tailpieces, then one drug, then another, and finally the needle tips.

Check darts and gun before using.
Always inspect your dart gun prior to use to insure that it is unloaded and the barrel clean and clear. If you are using any form of electronic sights, be sure that they are working (and *always* carry spare batteries!). If you are using reusable aluminum darts, place both ends of the dart body into the gun barrel to be sure that they have not distorted from previous firings. If both ends of the dart do not fit smoothly into the barrel, do not use it.

Don't load gun until ready to approach the animal.
Until you are actually in a position to approach and dart an animal, it is generally unnecessary to load your dart gun. Remember dart guns are exactly that – guns! At close ranges, dart guns can be lethal and they should always be treated like their bullet-firing counterparts. Keep the safety on or the gun uncocked until just before you shoot. Also never load a dart gun in a helicopter until you are in position to dart the animal. Before loading, point the barrel outside of the aircraft and keep it there. I'll leave it up to your imagination as to what an accidentally-discharged dart can do inside the cockpit.

Approach

Approach captive animals quietly and calmly.
Even if you are working with captive animals that are restrained in a chute or a trapped wild animal, you should approach it quietly and calmly. Do not make rapid or exaggerated movements that will panic the animal. Captive animals will often pace or run back and forth if they see you approach too closely which makes accurate shot placement difficult. If your approach cannot be hidden, don't "focus" too much on your intended target. Animals seem to know when you are interested specifically in them and they become increasingly nervous. If captive

animals are used to a routine such as feeding or cleaning, try to mimic that activity (at the same time of day) to allow a closer approach.

Use devices to approach free-ranging animals.
Approaching a free-ranging or captive animal close enough so that you can get a suitable shot with a dart gun can be frustrating. Free-ranging animals, if shot from the ground, are best shot from a blind overlooking a feeding station or some other device that draws the animal into range. Wild animals can often be approached quite closely with a vehicle, but you must remain inside the vehicle even when taking a shot. If using a vehicle or helicopter to pursue and dart animals, try to limit the length of the chase. Many ungulates have evolved for quick bursts of running only and are physiologically ill-equipped for long-distance pursuits. Such species, if run too hard, will survive the immobilization process only to die several hours or even weeks later due to capture myopathy or stress-related diseases.

Estimate distance and wind.
Many dart guns can be adjusted to deliver more or less propellant to the dart. Additionally, .22-cal.-powered dart guns can use different power loads for different ranges. If possible, estimate the probable shooting distance that you expect to encounter and adjust the metering device and use the power load appropriate for the distance and dart weight. However, be prepared to adjust these factors at the last moment; if in doubt, it is better not to shoot. Overpowered darts can cause severe wounds or death; underpowered darts can miss altogether (thus spooking the animal) or strike the lower legs resulting in injury or poor drug absorption and prolonged induction times.

Also be sure to consider wind speed, particularly with crosswinds, when using lightweight darts or shooting at long distances (>15 m). Increasing your power settings can help ameliorate wind drift, but this step should not be taken when darting small or thin-skinned animals. The change in wind conditions experienced at the outer edge of the downdraft caused by helicopter rotors can change the angle of flight of lightweight darts; heavier darts tend to overcome this deflection.

Administration Sites

Intramuscular Injection
Immobilizing drugs are almost always administered IM. The usual injection sites are the large muscle masses of the proximal hindlimb and forelimb, with the former being the most commonly used (Figure 2). Hindlimb injections preferably should be placed towards the rear so as to avoid the femur; forelimb shots should be placed towards the front. Although anatomically small, a surprising number of darts strike the spine of the scapula. Also, the posterior portion of the scapula is not well muscled and long-needled darts (> 1 in.) can lodge in the bone, even in an animal the size of an elk. Darts striking the bone are painful, can cause fractures, and may not inject the drug due to blockage of the dart needle.

There is some evidence that intramuscular absorption rates can differ depending on site; absorption being most rapid from the neck, then the shoulder, then the hip (Berrie, 1972). Areas of large fat deposits should also be avoided as absorption from these sites is slow and unpredictable. For example, bears should be injected in the lower regions of the hindlimbs to avoid the fat deposits around the rump (Figure 3) or the shoulder. Some drugs, such as the barbiturates, have historically been given intraperitoneally (Erickson, 1957). However, this can result in slow absorption as well as possibly causing peritonitis.

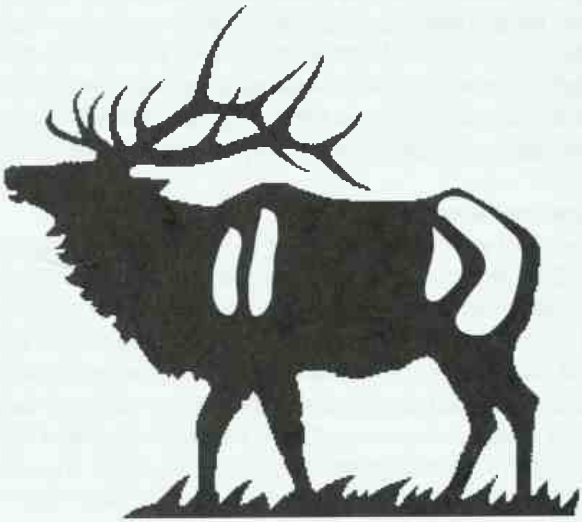

Figure 2. Intramuscular injection sites in large mammals. The spine of the scapula and the femur should be avoided, if possible.

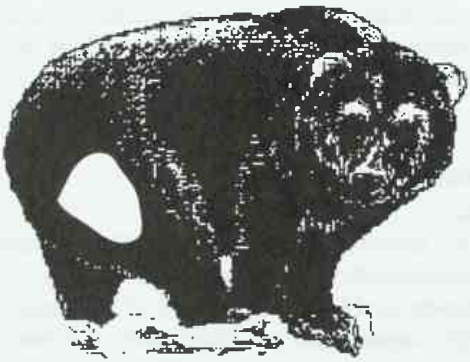

Figure 3. Hindlimb intramuscular injection site on bears. The distal portions of the hindlimb musculature are preferred so as to avoid fat deposits around the rump.

Intravascular Injection

Intravascular (IV) administration is usually reserved for antagonists; IV administration of immobilizing agents should be done with caution, as the onset of action is often quite rapid and, in some cases, respiratory depression or arrest can occur. Any drug containing propylene glycol (i.e., diazepam) should be given slowly IV, because a bolus can cause cardiac arrest. Intravenous administration of antagonists could result in very rapid recovery; be sure that you have a cleared escape route in mind and that all hobbles and blindfolds have been removed. For example, elk heavily sedated with medetomidine recover quickly and are fully sensate after antagonism with atipamezole. If you are too close to this animal upon recovery, it may strike out at you rather than running away.

Oral Administration

Oral administration is not often used in wildlife immobilization primarily because of the difficulty in predicting the dose that the animal receives. Also, drugs taken orally have variable absorption rates, resulting in prolonged and erratic induction and recovery times. Immobilizing drugs can be placed in tabs that are attached to traps so that when a captured animal chews on the trap, it ingests the drug (e.g., diazepam for foxes and coyotes). Drugs can also be placed in food baits, but it is particularly difficult to predict the administered dose with this method (Ratcliffe, 1962; Montgomery and Hawkins, 1967). I have heavily sedated gray wolves by placing concentrated tiletamine-zolazepam (Telazol®) into bait. If other methods of administering drugs fail, one can spray drug into the mouth of the animal. This seems to works best with the cyclohexane class of drugs.

Immobilization Signs

Although some immobilizing drugs do not cause true anesthesia (loss of consciousness and analgesia), most of the commonly used drugs or drug combinations do. The classic stages of anesthesia were initially defined for ether (Table 1) and they are applicable to the more modern agents only in the broadest terms. However, it is important to remember that Stage II of anesthesia (Delirium or Excitement) is often applicable to many modern drugs, particularly the opioids. During this stage, the animal loses voluntary control and may stumble or fall, particularly if the animal was *underdosed*. It is critical that the immobilizing dose be sufficient to minimize the duration of Stage II in order to drive the animal quickly through Stage II and into Stage III (Surgical Anesthesia) which is the desired stage. The ideal level of anesthesia is Stage III, Plane II. If the animal is *overdosed*, it will progress through the planes of Stage III with increasing physiologic impairment until it finally enters Stage IV (Medullary Paralysis) where death is imminent unless counteractive measures are taken (antagonist or respiratory stimulant administered, CPR, etc.).

Table 1. Classical stages of anesthesia as defined for ether anesthesia.

I Stage of Analgesia
- disorientation
- increased heart and respiratory rate
- excessive salivation
- urine and feces may be voided

II Stage of Delirium or Excitement
- delirium, excitement, struggling
- loss of voluntary control
- tachycardia, possible cardiac arrhythmias
- irregular respiration, possible apnea
- dilated pupils
- reflex vomition, defecation, urination
- loss of consciousness

III Stage of Surgical Anesthesia

Plane I
- increased depth and rate of respiration
- reflexes present
- normal pulse and blood pressure
- pupils constricted

Plane II
- regular depth and rate of respiration
- loss of reflexes
- normal pulse and blood pressure
- pupils normal; fixed eye movement

Plane III
- increased abdominal respiration as intercostal muscles become paralyzed
- rapid pulse; blood pressure falls
- pupils slightly dilated

Plane IV
- paralysis of intercostal muscles, abdominal respiration only
- pulse rapid; blood pressure continues to fall; impaired cardiac function

IV Stage of Medullary Paralysis
- respiratory arrest leading to circulatory collapse
- pulse, blood pressure weak then absent
- eyes fixed and dilated
- death within 1–5 minutes

Familiarity with the signs of anesthesia is essential – not knowing the depth of anesthesia can be lethal for both the animal and you! You can assess drug effect through changes in behavior (Table 2), but to determine such effects, it is critical to be familiar with the target species. Know what is normal and look for the abnormal.

Table 2. Sequential signs of chemical immobilization of animals given an injectable anesthetic. Not all signs are applicable to all species or all drugs.

- Slight behavioral changes
- Licking
- Lowering of eyelids
- Standing (not moving)
- Moving away from other animals
- Lowered head, standing
- Increased salivation
- Abnormal behavior
- Aimless walking
- Agitated walking and running
- Straddle-legged stance
- Down but able to rise on own
- Down but able to rise if stimulated
- Down but unable to rise—head up
- Down but unable to rise—head down
- Lateral recumbency
- Spontaneous movements present
- Loss of ear twitch reflex (touch inside of ear, ear twitches)
- Loss of pedal reflex (pinch toe, limb withdraws)
- Loss of swallowing reflex (pull tongue, release, animal swallows)
- Loss of palpebral reflex (touch eyelashes, animal blinks)
- Loss of corneal reflex (touch cornea, animal blinks)

Once the animal is down, you need to assess the depth of anesthesia. Always exercise caution when checking a downed animal. Approach the animal slowly and quietly; approach dangerous animals from the rear and be sure that you have an escape route. Initially observe for spontaneous, non-repetitive movements and, if present, you can usually assume that the animal is not fully immobilized. Repetitive, stereotypical movements are often seen with opioid agents. Such animals are effectively immobilized, but large ungulates can still deliver a crippling kick under these conditions! If the animal appears unconscious, check for ear twitch (touch inside of ear, ear twitches), pedal reflex (pinch toe, limb withdraws), swallowing reflex (pull tongue, release, animal swallows), palpebral reflex (touch eyelashes, animal blinks), and corneal reflex (touch cornea, animal blinks). If the

animal has lost the ear twitch, it is probably at an appropriate stage of anesthesia for most field procedures. The cyclohexanes often do not abolish the blinking reflexes, even when the animal is quite anesthetized. If the animal is down but not fully immobilized, you should assess the situation carefully by determining:

If the animal received all the drugs administered.
For example, there may have been partial dart-hits where all of the drug may not have gone into the animal. If your dart hit the animal, but bounced out almost immediately and the animal shows some signs of drug effect, chances are good that it only received a portion of the drug.

The animal's psychological state.
Was the animal was highly excited during the drugging episode? Highly excited animals can absorb a frightening amount of some drugs (particularly xylazine or ketamine/xylazine) before they finally can be approached. When dealing with highly-excited animals, such as deer, you may have to increase the suggested immobilizing dose by as much as 50%. Only experience will help you deal with these situations. Even though down, such animals still might not be unconscious – exercise caution!

The pharmacology of the drug and its therapeutic index.
Does the drug(s) have a sufficiently high therapeutic index that would allow you to safely give the animal more? Drugs such as ketamine can usually be administered at 2-3 times the recommended dose and still not cause problems. On the other hand, drugs such as succinylcholine have low indexes and booster doses can easily result in overdose and respiratory arrest.

How much time has elapsed since the drug was initially given.
Allow 10-15 minutes (15-20 minutes for opioids) to elapse after an IM injection before giving booster doses. In general, it is often safe to re-administer 50% of the original dose of the *primary* immobilizing agent; it is usually not necessary to give additional tranquilizer. For example, you used 500 mg ketamine and 100 mg of xylazine to immobilize a deer. The dart bounced out almost immediately and 15 minutes later the deer was stumbling about or even lying down, but it would get up or walk away when you tried to approach it. A safe and effective booster dose in this case would be 250 mg ketamine and no more xylazine.

If no sign of drug effect is apparent after 20 minutes, you can assume that the animal probably received little or none of the original dose. If you are confident that the drug(s) and dose(s) that you originally selected were appropriate, then give the animal the same drug(s) and dose(s) again. When using opioids and tranquilizers, some authors suggest re-administering the *entire* dose again if the animal is not completely immobilized 20 minutes after the first injection, regardless if there are signs of some initial drug effect or not.

Only when these factors have been considered can you make an informed decision on whether to administer additional drugs or abandon the immobilization attempt. Animals can be kept immobilized for extended periods (several hours) with supplemental boosters of 33-50% of the initial immobilizing dose. This is particularly true when using ketamine. Where ketamine was given initially in combination with another agent, such as xylazine or promazine, usually only the ketamine needs to be given to maintain immobilization.

Handling the Immobilized Animal

When an animal is finally "down" and can be safely handled, there are several immediate steps that need be taken before you embark on whatever action prompted the immobilization in the first place. This section lists those steps; their order is not absolute as obvious emergencies might take precedence. Specific emergency treatments are discussed in Chapter 4, *Emergency Treatment– Animal.*

Position body.

- Insure that nothing impinges on breathing, i.e., neck straight, nose/trunk clear.
- Position ruminants sternally or on their *right* side (left side can cause bloat and other complications). Most other animals can be placed on either side or sternally *except* for elephants which *must* be placed on their sides. The head should preferably be slightly lower than the thorax to avoid aspiration of fluids.
- Try to keep the animal on relatively flat ground to avoid occlusion of the trachea, pressure neuropathy, or circulatory impairment.
- If the animal is to remain immobilized for some time, roll the animal on its other side or sternally at least every 60 min. It is preferable to roll ungulates across the sternum as opposed to across the back.

Cover eyes.

Covering the eyes protects them from harmful ultraviolet light from the sun, reduces drying, and prevents dirt and debris from entering them. Coating the eyes with a lubricant further prevents drying, however, some feel that eye ointments result in dirt and grit sticking to the eye. A saline wash (e.g., contact lens saline) can also be used. Covering the eyes also appears to further calm the animal even when effectively immobilized.

Hobble the legs.

This is particularly necessary with ungulates to avoid spontaneous kicking which may injure someone. Hobbles also prevent other human injuries or possible escape should the animal partially or spontaneously recover.

Check vital signs.

Respiration

Once assured that the animal's body position will not affect breathing, you should

check its respiratory rate (RR). Regardless of claims, there are really very few scientifically-proven normal resting RRs of undrugged, wild animals. Experience with a given species and immobilization process is your best guide. Respirations can be seen (watch the abdomen or chest), felt (place hand in front of nostrils), or heard (place ear by nostrils – a very sensitive technique).

Slowed RRs are most likely drug-induced, but they can be caused by hypothermia. In cases of respiratory arrest or poor oxygenation, respiration can be supported mechanically or pharmacologically. Rapid RRs could indicate hyperthermia, bloat, aspiration, pulmonary edema, or shock. Use other parameters (i.e., temperature, capillary refill time) to differentiate the causes of a rapid RR and treat accordingly. If you have a stethoscope (and you should), listen for abnormal chest sounds such as gurgling which may indicate pulmonary edema. If the animal's gums (or other mucous membranes) are pinkish (as opposed to blue, gray, or muddy), tissues are probably adequately oxygenated, even if the RR is < 5-6/min.

Portable pulse oximeters are the best means for assessing respiratory efficiency because they measure oxygen saturation of hemoglobin. The trend of oxygen saturation is usually more informative than absolute percents. That is, if the percent oxygen saturation falls from 90% to, say, 70%, then you need to determine the cause. In general, oxygen saturation percents above 90 are desirable, but immobilized animals often have percents in the 80's with no apparent harm.

Temperature

Always carry a thermometer and *use* it continually throughout the immobilization period. Normal mammalian rectal temperatures range from 37.5–40° C (99.5–104° F). Cell damage may begin when oxygen demand exceeds supply at temperatures > 40 °C (104° F). You should probably take action to lower an animal's temperature if it is > 40 °C (104° F); such action is mandatory at temperatures > 41.1 °C (106° F); survival without residual impairment is questionable at temperatures > 42.2 ° C (108° F); survival itself is doubtful at temperatures ≥ 43.3 °C (110° F).

Conventional large animal glass thermometers are sufficient, but they are slow and they easily break. If using glass thermometers, tie a bright string to it and have a clip attached to the free end. When using the thermometer, clip the string to upper side of the animal so that you can see the string. This serves as a reminder to remove the thermometer before you release the animal! I personally favor electronic digital thermometers, particularly those with a probe. These devices are inexpensive, fairly rugged (saltwater is death to them, however), and rapid. I insert the probe into the rectum and place the unit on the up side of the animal where I can check the temperature periodically by simply pushing a button.

Pulse

Again, there are very few proven, normal resting heart rates of wild animals, so let

experience be your best reference. Smaller animals generally have higher heart rates than larger animals. Heart rates can be detected: 1) with a stethoscope (usually best detected on the "down" side of the animal, between the fourth to sixth ribs or behind the point of the elbow); 2) by feeling the heart beat directly by compressing the chest slightly; 3) by locating an arterial pulse; or 4) by using a pulse oximeter or electrocardiogram.

A very fast heart rate could be a function of drugs (e.g., ketamine), physiological responses (i.e., stress, excitement), hyperthermia, or shock. Use other parameters to differentiate the causes of tachycardia. An abnormally slow heart rate could be a function of drugs (e.g., xylazine), hypothermia, or metabolic disorders (e.g., hyperkalemia, hypercalcemia). Generally, if the capillary refill time (see page 93) is < 2 sec, adequate perfusion is assumed and no action is required in the absence of other signs.

Check for wounds, injuries, and general condition.
Start from the nose and work toward the tail. Look for blood, swelling, hair loss, and abnormal body configuration (e.g., fractures or luxations).

- Nose: check for blood, excess fluid, dirt, foreign objects.
- Mouth: check for jammed sticks (particularly with trapped carnivores), broken teeth, lacerated tongue, dirt, etc.
- Eyes: clear of dirt, lubricate, and cover.
- Ears: blood could indicate concussion, but could be due to ectoparasites.
- Chest: listen for gurgling, moist sounds, rasping (think edema, pneumonia).
- Abdomen: watch for signs of bloat.
- Limbs: check for lacerations, fractures.
- Feet: check for lacerations, fractures of toes, imbedded sticks, burrs etc.
- Anus: check for bleeding (think hyperthermia), diarrhea.
- Skin: check for lacerations, abrasions. Also check for dehydration by pinching loose skin (e.g., back of neck) to form a "tent." Upon release, the "tent" should collapse within 1 second. If the pinched skin remains raised or resumes its normal configuration slowly, the animal is probably dehydrated Also check for ectoparasites (ticks, mites, lice). Treatment for a heavy parasite infection may not be feasible, but a high parasite load may indicate an animal in marginal condition which could have impact on its recovery from immobilization or long-term survival.

Do not make loud or sharp noises.
Animals that have been immobilized with opioid agents often spontaneously respond to loud or sharp noises, such as a slammed truck door. The response is usually a kick, but such animals may try to stand. When using opioids, you may wish to plug the animal's ears (be sure to remove these plugs when you are done!).

Animals immobilized with cyclohexane agents are usually less responsive to sound. I usually do not try to be overly quiet around such animals, because I feel that

some noise may serve to partially stimulate the animal resulting in an "early warning" of recovery.

Recovery of the Immobilized Animal

An animal should not be left unattended until it starts to recover from the immobilization. Ideally, you should remain with the animal until it can walk in a relatively coordinated manner (i.e., respond appropriately to objects, people, other animals) whether an antagonist was administered or not. At the minimum, you should stay with the animal until it can at least raise itself to a sternal position. Look around the recovery area for possible hazards such as sharp rocks and ledges. Either relocate the animal or stay with it through recovery so as to direct it away from such hazards. Animals recovering while on a slope will usually travel downhill. And what is often at the bottom of a hill? Water. More often than not, a recovering animal will stumble downhill right into a lake or stream. Be prepared to take heroic actions if this happens! Keep the animal cool or warm, depending on weather conditions (i.e., out of the sun in summer, in the sun during winter), dry, and free from inter- or intraspecific harassment or aggression.

Euthanasia

Invariably, there will come a time when an animal must be euthanized either because it has been critically injured or it is terminally ill. If an animal needs to be euthanized, it should be done safely and effectively with some consideration for the dignity of the animal and the sensitivities of the public. Many methods of euthanasia, such as shooting and stunning, are effective and medically acceptable but are reprehensible to the public (or even other biologists!). Chemical euthanasia is generally the preferred method because it is safe, effective, and aesthetically acceptable. Listed below are the various methods of euthanasia that are generally employed for wildlife. Other methods, such as carbon dioxide and inhalant anesthesia, are not listed only because they are not practical for field application. A detailed discussion of euthanasia methods appears in the Journal of the American Veterinary Medical Association, Vol. 202, No. 2, January 15, 1993, entitled, *1993 Report of the AVMA Panel on Euthanasia.*

Note: It should be remembered that no animal that has been chemically immobilized and then euthanized by physical methods or one that has been directly euthanized via chemical methods can be used for human or animal food consumption.

Physical Methods

Cervical Dislocation

Cervical dislocation can be used to euthanize birds, small rodents, and rabbits. For

mice and rats, the thumb and index finger are placed on either side of the neck at the base of the skull. With the other hand, the hind limbs are quickly pulled, causing separation of the cervical vertebrae from the skull. For small rabbits, the head is held in one hand and the hind limbs in the other. The animal is stretched and the neck is hyperextended and dorsally twisted to separate the first cervical vertebra from the skull. For birds of poultry size or smaller, cervical dislocation is accomplished by stretching and twisting.

Decapitation

Decapitation is generally not acceptable due to animal (and public) distress.

Exsanguination

Exsanguination (bleeding to death) is acceptable *only* if the animal has been rendered unconscious by drugs or stunning. It is often a slow, messy, and unsightly process. Bilateral sectioning of the jugular or femoral veins can be effective, but often the blood flow slows after awhile. If possible, try to severe the major arteries leading from the heart by inserting a long-bladed knife into the junction of base of the neck and shoulder and slicing inwards and downwards.

Stunning

Stunning by a sharp blow to the head with a hard object can be used for smaller animals (< 5 kg). Stunning by a penetrating captive bolt can be used on larger animals including the largest hoofstock. The disadvantage of any method of stunning is that it may not cause death, so you must check that the animal is dead by monitoring heart rate, respiration, or pupillary reflex. If you are not sure that the animal has expired, it is wise to insure death by exsanguination. Note: *non*penetrating captive bolts are *not* recommended as a method of euthanasia.

Gunshot

Gunshot is often the most practical, if not only, means of euthanizing wild animals. Ideally, the animal is under some sort of physical or chemical control so that carefully-placed shots can be made. If the animal is not controlled, head or neck shots are preferable to heart or lung shots. If the animal is under physical control or chemically immobilized, the best target for shooting is at the intersection of two imaginary lines connecting the ears with the contralateral eyes. A .22-caliber bullet is adequate for animals < 200 lb if fired at a distance of < 1 foot. Large, heavy-skulled animals (e.g., bears) usually require more powerful bullets. Whatever bullet is used, remember that placement is more critical than caliber. Be sure that all personnel stand behind the shooter; bullets hitting bone can take off at unexpected angles. Place the muzzle of the gun as close to the animal as feasible and aim at juncture of the "X" connecting the ears and eyes. On large animals, or animals with heavy skulls, you may want to shoot at a point slightly off center of this imaginary intersection. Try to insure that the shot is placed as perpendicular to the skull as possible; bullets fired at a shallow angle may bounce off thick skulls.

Although euthanasia by gunshot (or penetrating captive bolt) is usually instantaneous, the animal may thrash and convulse for several seconds after the shot. Large ungulates can deliver bone-breaking kicks during this period, so wait several seconds after cessation of thrashing to handle the animal.

Chemical Methods

T-61®

T-61® is an injectable nonbarbiturate, non-narcotic mixture of three drugs. These drugs provide a combination of general anesthesia, curariform, and local anesthetic actions. T-61® is no longer available in the U.S., but it is in Canada. It must be administered intravenously.

Barbiturates

Several euthanasia products are formulated to include a barbituric acid derivative (usually sodium pentobarbital) with added local anesthetic agents (e.g., Beuthanasia®-D Special; FP-3®). These drugs are Schedule III controlled substances. Barbiturates are generally the preferred method to euthanize animals and they are acceptable for almost all species and sizes of animals. Intravenous injection is the preferred route, although intraperitoneal (IP) and intrathoracic injections can be given to small animals and birds. Animals euthanized with barbiturate solutions must be cremated for disposal.

Potassium Chloride

Another method of euthanasia that is available to everyone is IV injection of potassium chloride. Increasing the level of circulating potassium (hyperkalemia) in the blood directly influences electrical activity of the heart resulting in cardiotoxicity and arrest. Potassium chloride can be inexpensively obtained from chemical suppliers. Potassium chloride is also available in grocery stores as "light salt" which is a substitute for sodium chloride. To prepare a solution, mix approximately 2 gm of potassium chloride with 10 ml of water (sterile water, physiological saline, distilled water, or even tap water). Shake vigorously and immediately draw into a syringe as the potassium chloride will settle out quickly of this saturated solution. This solution *must* be given IV and administered at a dose of 2 gm potassium chloride per 50 kg body weight. It is critical to remember that the animal *must be anesthetized* before it is administered. Because of the disruption of electrochemical conductivity, hyperkalemia can be very painful and therefore would be inhumane to administer to a conscious animal. It should go without saying (but I'll say it anyway) that potassium chloride should not be given to an animal immobilized with neuromuscular blocking agents. Cardiac arrest is quite rapid (< 30 sec) and should be verified by listening for heartbeat or feeling for a pulse.

Equipment

Introduction

This section is concerned with the equipment for delivering drugs to animals and for monitoring the effect of those drugs. All of the drug delivery equipment described herein can effectively immobilize animals – given the appropriate conditions. That is to say, there isn't one type of system that can be used on all animals at all times. This fact is sometimes difficult to accept, particularly when buying decisions are limited by fiscal constraints. You possibly can get by with only a 0.50-caliber dart rifle having variable power settings. The well-equipped professional, however, will have multiple dart guns (pistol, CO_2 and .22 cal. rifles), pole syringe, and blow pipe (or powered blow pipe).

Another mistake (in my opinion) that is commonly made in the selection of equipment is a reluctance to spend money on it. There are many ways to make your own darts from syringes, blow pipes from conduit, dart guns from modified shotguns, etc. In all probability, none of this equipment is as good as what is commercially manufactured. Manufacturers have spent years and significant amounts of money in the development of their products. The result of their efforts is good quality equipment that performs as expected, is fairly rugged and dependable, and is backed by a knowledgeable service department. This is not an advertisement for the manufacturers listed in this section; this is experience. I've tried all the "cheap" ways of making my own equipment and I don't use any of it anymore. Professionals use professional equipment.

Most animal immobilizations are done "remotely," that is, there is no direct contact between you and the animal. Darts, propelled by a variety of means, are the usual means of delivering drugs remotely to animals. Systems capable of propelling darts are termed *remote delivery systems* (RDS) and they are defined as "mechanical devices capable of administering a single dose to an unrestrained animal, usually by means of a ballistic projectile."

Remote drug delivery dates to pre-Columbian times when aboriginal natives of Africa and South America dipped arrows, spears and blow darts in preparations of muscle-paralyzing drugs derived from plant and animal sources (Bush, 1992). Modern delivery systems have their genesis in the 1950's when the first projectile

dart capable of delivering a liquid drug was reported (Crockford et al., 1957). This dart became the predecessor of darts still used today. Many types of delivery systems were developed in the following three decades, but only a few proved reliable and versatile enough to survive competition in a limited market. There are both advantages and disadvantages of RDS used to administer drugs.

Advantages of RDS

Specific animals can be targeted.

As opposed to baiting or trapping, animals can be selected and captured based on sex, size, age, or status.

Drugs can be administered on a body weight basis.

Biologists familiar with a species can often estimate body weights of free-ranging animals quite accurately. Fairly precise doses can then be administered under field conditions if necessary for research purposes or efficacy.

A wide range of volumes can be delivered.

Depending on the projectile type and volume, liquid doses ranging from a few µl to as much as 25 ml can be delivered.

Some RDS can both treat and mark individual animals.

Some projectiles can be equipped with marking dyes and others can deliver electronic identification devices along with the drug.

Disadvantages of RDS

The target animal must be first located and then approached closely.

Under most circumstances, animals must be to within 75 m or less for projectile RDS to be effective. Many species are secretive and extremely difficult to locate, let alone approached closely.

Many RDS can only be used on larger animals.

Those RDS using projectiles are not terribly accurate and the preferred target area on smaller animals may only be a few square centimeters. The shot could either be misplaced causing injury or death or it could miss the animal entirely. Even if placed correctly, the impact energy or penetration depth could be injurious or lethal to smaller animals. As a general working rule, only animals weighing > 15 kg (33 lb) should be targeted when powered (e.g., CO_2 or .22-cal. systems) RDS are used. If possible, use blow pipes for smaller animals.

RDS are inherently complex.

There are many system variables that can fail or affect successful delivery. A working maxim could well be, "everything that can possibly go wrong with RDS, eventually will!"

Many RDS are noisy.
Some RDS may spook other animals after the first shot is fired rendering subsequent shots at other animals difficult or impossible.

Training and experience is necessary.
RDS should not be used without some degree of formal instruction by experienced practitioners of remote delivery techniques, and RDS should never be used without fairly intense practice by the user in order to assess the performance of the device prior to using it on an animal.

Syringes and Needles

Hand syringes and needles are the basis for any drug delivery system. Not only are they used to administer drugs directly to restrained animals, they are also used for measuring and loading immobilization drugs into other delivery devices such as darts. Syringes and needles are also required for taking blood samples and administering antibiotics and other drugs. Most syringes and all needles are sterilized and disposable, and they are intended to be used once and discarded. Some syringes are designed for multiple uses, but these are not commonly used for animal immobilizations.

You can never have enough syringes in your kit, because you will consume them rapidly. For example, a syringe used to measure or administer an anesthetic shouldn't be used to administer any antagonist (there could be residual anesthetic in the syringe). Also, any syringe that is used for an intravenous injection in one animal should not be used on another animal because it will be contaminated with blood. Likewise, you can't have too many needles on hand. Needles should be used to withdraw and/or administer only one type of drug; not be used on more than one animal; and should *not* be reused for any reason. The basic philosophy here is to avoid cross-contamination of either drugs or animal fluids.

Syringes are available in an assortment of sizes, but 1 ml, 3 ml, 5-6 ml, and 10-12 ml are the most commonly used. Larger sizes (≥ 20 ml) are useful for taking blood samples from large animals when such samples are required for multiple assays. The use of a single large syringe prevents multiple holes being poked in the animal! Needles also come in a variety of gauges (inside diameter measurement) and lengths. The *larger* the gauge, the *smaller* the inside diameter. For example, a 25-gauge needle is much smaller than a 16-gauge. Needle lengths can vary from 0.625 inches to > 3 inches (please excuse the departure from the metric system here). Needle sizes that you will find most useful are 20 (or 21) gauge by 1 inch, 18 gauge by 1 or 1.5 inches, and 16 gauge by 1 or 1.5 inches.

Manufacturers: Several worldwide
Specifications: Syringes: 1–60 ml, plastic, sterile, disposable or reusable

- Needles: 27 to 12 gauge, sterile, disposable. The *smaller* the gauge, the *larger* the inside diameter of the needle. Needles come in various lengths, the most common in North America being 1 and 1.5 inch.

Range: Arm's length

Operation: Insert a needle (without syringe) into the space at the top of the drug vial to equalize air pressure. This may be particularly important when vials have been at different altitudes. Be careful that a pressurized vial does not eject drug uncontrollably. Attach syringe to needle or use a new needle.

- Attach a new needle to the syringe by pushing then twisting to assure a secure fit so that the needle does not remain in the animal after injection. Remove the protective needle cap by pulling straight away from the syringe (do not pull and twist, or the needle will come off also).
- To avoid developing a vacuum within the vial, withdraw the syringe plunger to a point equal to the desired drug volume. Insert the needle into the drug bottle and inject the air from the syringe into the bottle, but do not over-pressurize. This step may not be necessary when withdrawing small volumes (< 5 ml). Hold the bottle upside down and withdraw the appropriate drug volume as indicated on the syringe barrel gradations. After withdrawing the needle from the bottle, carefully expel any air from syringe to obtain an accurate amount of the drug, but avoid spraying the drug and perhaps causing accidental human exposure.
- For intramuscular (IM) injections, use a large-bore needle (16–18 gauge) on large (≥ 30 kg) animals and smaller needles (20–25 gauge) on smaller animals.

Figure 4a. Withdrawing blood from the cephalic vein of a mountain lion. Note the left hand compressing the proximal vein and the angle of the syringe. The black line between the syringe and the hand marks the location of the vein.

Figure 4b. Withdrawing blood from the jugular vein of a mountain lion. The black line between the syringe and the hand marks the location of the vein.

Figure 4c. Withdrawing blood from the femoral vein of a mountain lion. The vein is located on the inside of the hind leg. The black line between the syringe and the hand marks the location of the vein.

Inject the drug into the muscle mass quickly and withdraw. However, if animal restraint permits, first withdraw the plunger slightly to verify that the needle is not in a vein (blood will appear in the syringe), and then inject the drug. Be sure to avoid major nerves and bone - know your animal's anatomy!

- For intravascular (IV) injections, use smaller needles (18-21 gauge) as appropriate for the size of the animal. Common veins for IV injection are the cephalic (Figure 4a) and jugular (Figure 4b). Other veins accessible in larger animals are the femoral, running along the inside of the thigh (Figure 4c), and the saphenous, located along the outside of the hock.
- Compress the vein with your fingers or hand so that blood is blocked from returning to the heart. Then insert the needle into the turgid vein on the side of the compression away from the heart (Figure 4a).
- For superficial veins, such as the cephalic, insert the syringe at approximately a 10-20° angle to the surface of the animal; for deeper veins, such as the jugular or proximal femoral veins, increase the angle of penetration. For superficial veins, the bevel of the needle should be facing up toward the surface of the animal so that the needle opening does not become occluded by the walls of the vein (Figure 5).
- When the needle slips into the vein, pull back the plunger slightly to withdraw blood to verify that the needle is in the vein, release the proximal vein, inject the drug (or withdraw blood for a sample), and then remove the needle.
- Lastly, compress or rub the injection site to hasten coagulation.

Comments: Keep the protective cap on the needle until just before you intend to inject the drug – syringes with exposed needles just look for a place to inject themselves! Also when replacing the needle cap, it is good practice to brace both hands to steady them. This is particularly true when using potent drugs. Poking oneself with a needle is the number one cause of accidental human exposure (Petrini et al., 1993).

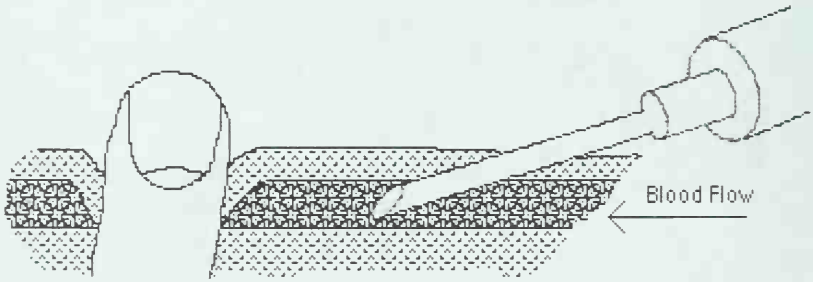

Figure 5. For superficial veins, insert the syringe at approximately a 10-20° angle to the surface of the animal. The bevel of the needle should be facing up toward the surface of the animal so that the needle opening does not become occluded by the walls of the vein.

Pole Syringes

Pole syringes are exactly that – a syringe on the end of a pole. These are very useful tools with broad applications, such as administering drugs to trapped or caged animals or safely giving additional drugs to animals not completely immobilized but approachable. Pole syringes are usually limited to administering ≤ 10 ml of drug because the animal will usually not hold still long enough to give larger volumes. Homemade pole syringes can be easily and cheaply constructed but none seem to work as well as the manufactured versions.

Manufacturers: Dan-Inject, Advanced Injection Systems, Paxarms, Zoolu
Specifications: Syringe volumes range from 2.5–20 ml. The syringe portion can vary from modified, disposable to heavy-duty, reusable syringe barrels. Needles are usually conventional needles designed for hand syringes. Shafts can be constructed of aluminum, steel, or composites and they usually are capable of adding extensions to increase pole length.
Range: 0.5–3 m, depending on shaft length
Operation: It is usually preferable to withdraw drugs with a conventional hand syringe and then using that syringe to transfer the drug into the pole syringe. Drugs may also be withdrawn directly from a vial using the pole syringe if care is taken and accurate drug volumes can be assured.

- Use a large-bore needle (16–18 gauge) on large (≥ 30 kg) animals and smaller needles (20–25 gauge) on smaller animals. Inject the contents IM rapidly and firmly and withdraw before animal can bite or kick pole. The muscle masses of the hindquarters are the preferred sight for injection, but the shoulder muscles of larger animals can also be used.

Comments: Long pole syringes (≥ 3 m) are to difficult to aim accurately (your arm movements are greatly magnified) and are best used on larger animals with their larger target areas.

Blow Pipes

Blow pipes, or blow guns, are useful devices for delivering small volumes of drugs at short to medium ranges. They operate by propelling a dart through a pipe or tube either by rapid expulsion of one's breath, by compressed air, or by CO_2. Blow pipes using compressed air or CO_2 are usually referred to as *powered blow pipes* and they are capable of greater ranges than conventional pipes using lung power.

Conventional (lung-powered) blow pipes consist of one- or two-piece aluminum tubes measuring up to 2 m. Most propel 10 mm-diameter darts having a maximum capacity of 3 ml. Their effective range is limited (< 20 m). Blow pipes are quiet and they usually cause little trauma to the animal in that the dart neither strikes the animal with much velocity nor does the method of dart operation cause injury (see later); animals as small as 3 kg (6.6 lb) can be safely treated. Blow pipes are used

primarily on captive animals, but they can be used effectively on free-ranging animals under the right circumstances, such as treed animals or animals approached closely by vehicle (Brockelman and Kobayashi, 1971; Haigh and Hopf, 1976).

Powered blow pipes consist of an aluminum tube connected to a pistol grip containing a metering device and reservoir. Air is compressed by a foot pump connected by a hose to the pistol grip. After the desired pressure has been built up in the reservoir, the hose can be disconnected. When the trigger is pulled, the compressed air is released, propelling the dart. Similarly, some powered blow pipes use CO_2 cartridges that feed into a reservoir that can be adjusted to either increase or decrease the amount of pressure. Because the dart flight distance is proportional to the pressure built up in the reservoir, these devices have a wide effective range from 1-30 m. Powered blow pipes propel the same type of lightweight darts (10-11 mm diameter; 1-3 ml volume) as do conventional blow pipes and they are preferred for delivering larger volumes at longer distances.

Manufacturers: Advanced Injection Systems, Dan-Inject, Pneu-Dart, Telinject
Specifications: Dart volumes usually range from 1–5 ml
Range: Up to 30 m
Operation: For lung-powered pipes, sight over the end of the pipe at the intended muscle mass, inhale through nose (don't swallow the dart!), insure tight seal between lips and mouthpiece, expel air sharply but not explosively (excessive force causes dart to bounce off animal).

- For powered blow pipes, aim like a pistol. Squeeze the trigger quickly (slow trigger pull may prevent the air/gas from being released in a burst).

Comments: The longer the blow pipe the greater the potential distance the dart can be propelled, however, long pipes are unwieldy and more difficult to aim.

- Use of blow pipes to deliver potent drugs should be avoided to prevent accidental human exposure.
- Blow pipe use in some states and countries, such as Canada, is prohibited without a special permit. If in doubt, check it out.

Longbows/Crossbows

Arrows or crossbow bolts can be modified to administer a liquid product up to 5 ml upon impact (Anderson, 1961; Short and King, 1964; Hawkins et al., 1967). Longbows and crossbows, though, have generally fallen out of favor because of impact trauma. If used at all, they are usually limited to larger animals shot at long ranges.

Manufacturers: Palmer (arrow adapters)
Specifications: Syringe capacity probably limited to < 5 ml
Range: Potentially 100 m, but accuracy usually limits range to < 50 m
Application: Should be limited to IM injection of large (> 100 kg) animals

Operation: A dart is attached to end of arrow using an adapter. The dart contents are expelled by powder charge upon impact (also see *Darts*). Aiming is similar to a bow or crossbow, but practice is necessary to determine range and accuracy.
Comments: Bows are seldom used now since dart guns are more accurate and less traumatic. Due to the velocity, weight, and inaccuracy of arrows, mortalities with longbows can be as high as 33% (Hawkins et al., 1967).

Dart Guns

The most widely used RDS are dart-shooting guns. Some dart guns have been constructed by modifying existing shotguns, rifles, pistols, pellet rifles, or pellet pistols; other guns are almost entirely custom-designed and manufactured for this purpose. Dart guns propel darts by either the gas generated from a .22 caliber blank cartridge, compressed CO_2, or compressed atmospheric air. Dart-firing guns are the most versatile of the RDS. Effective ranges can be as far as 75 m and possibly up to 100 m for larger animals having larger target areas. Dart volumes can be as much as 25 ml, although these larger, heavier darts drop rapidly after leaving the barrel making long-range, accurate shots difficult.

All darts, of course, begin falling as soon as they leave the barrel, but small darts (1-2 ml) traveling at higher velocities shoot "flatter" and farther than do large darts. Guns can be equipped with a variety of sights including adjustable open sights, rifle scopes, laser aiming devices, and light-intensifying scopes (so-called "night scopes" or "starlight scopes"). Open sights are preferred by many professionals, especially those who dart animals from helicopters. Rifle scopes make aiming easier, unless the animal is at close range where the magnification of the scope makes it difficult to identify where on the animal you are aiming.

Each of the three types of dart gun propulsion systems have advantages and disadvantages (Table 3). These properties are listed to help first-time users decide on an appropriate gun. In my opinion, there is no one perfect dart gun for all circumstances. If finances limit your arsenal, I would choose a .22 caliber-powered gun having a range-adjusting device. Even then, the final choice of a dart gun is much like the choice of a conventional firearm; it is a highly personal decision comprising a mix of objective analysis and emotional attraction all tempered by fiscal reality! The criteria analyzed in Table 3 for each system include:

Maximum Effective Range

This is the maximum distance at which the dart can be safely and effectively delivered. The range of most guns can be decreased from this maximum either through the use of a built-in metering device which directs little to all of the gas to the dart; by using different strengths of propellant (i.e., different sizes of .22 blanks); or by pushing the dart further down the barrel to reduce its velocity and thus its range. This criterion does not include the ranges of dart pistols which are usually limited to <10 m.

Dart Volume
Dart volumes range from 1–25 ml, however, not all guns are capable of delivering this full range of dart sizes.

Availability of Propellant
This category rates the ease of obtaining the propellant from local suppliers.

Temperature Sensitivity
The vapor pressure of some gases (e.g., $C0_2$) is temperature dependent. At cold temperatures, darts travel less far due to decreased vapor pressure. In extremely cold conditions, some guns may barely function without some means of warming the gas.

Impact Injury
The impact energy of the dart striking the animal is a function of its mass and velocity ($KE = 1/2\ MV^2$). It is a common misconception that light darts always cause less impact, and thus injury, to the animal than heavy darts; light darts fired at high velocities actually strike the animal harder (Table 4). Even on a large animal struck correctly, the dart can cause hemorrhage and hematoma. Misplaced shots can break bones or even kill the animal (Thomas and Marburger, 1964).

Report
Muzzle report can cause problems in darting either captive or free-ranging animals. For some animals, this noise can be more disturbing then getting struck with a dart. Disturbed animals are then more difficult to approach for another shot or the entire group of animals may run away.

Maintenance
Some guns need to be cleaned frequently in order to remain operable.

Performance Reliability
Guns are classified regarding consistency of shot-to-shot performance.

Ease of Use
Guns are classified relative to their simplicity of operation or ease of use under field conditions.

Overall Versatility
The above categories are evaluated to arrive at a subjective opinion on the overall versatility of the propulsion system.

Table 3. Characteristics of powered dart guns.

Category	.22-cal. Blank	CO_2	Compressed Air
Maximum Effective Range (m)	90	50	50
Dart Volume (ml)	1-25	1-10	1-10
Availability of Propellant	High	Medium[a]	Low[b]
Temperature Sensitivity	None	High	None
Impact Injury	High[c]	Medium	Med-Low
Report	Med-High	Med-High	Med-High
Maintenance	High	Low	Low
Performance Reliability	Medium	High[d]	High
Ease of Use	High	High	Low
Overall Versatility	High	Medium	Low

[a]There are two general types of CO_2 cartridges: threaded and unthreaded. Most sporting goods stores carry the smaller, unthreaded $C0_2$ cartridge, but the larger, threaded $C0_2$ cartridge may be very difficult to procure when working in rural areas.

[b]This rating refers to systems using compressed air tanks only and does not apply to systems using foot or hand pumps. Most fire departments can fill air tanks, but they are reluctant to do so because of liability concerns. Welding shops may have compressed air, but not always. Scuba shops have air compressors, but they usually do not have the necessary fittings required for the tanks used with dart guns.

[c].22 blanks come in a variety of strengths. Charge strengths are coded by different colors, usually brown, green, yellow, red with red being the most powerful. Darts propelled with either the yellow or red charges are capable of causing significant injury or death, but all charges can cause injury if fired at too short of a range or at too small of an animal.

[d]$C0_2$ cartridges generally provide consistent performance except when the propellant runs low. There is only a subtle drop in performance between the last acceptable shot and the next shot where the dart drops precipitously due to a rapid drop in pressure. Experienced shooters often only allow a fixed number of shots per cartridge before changing cartridges even though some shots remain.

Table 4. Kinetic energy produced by darts traveling at different velocities.

Weight (lb)	Velocity (ft/sec)	Kinetic Energy (ft-lb)
0.022	200	13.7
0.033	200	20.6
0.022	300	30.8

Kinetic energy calculated by $KE = 1/2\ MV^2$. Non-metric values are reported in order to compare with other ballistic data.

Manufacturers: Gerwig, Palmer, Paxarms, Peter Ott Co., Pneu-Dart , Telinject, Zoolu Arms

Specifications: Darts propelled by compressed air, CO_2, or .22 caliber blank cartridge.

Range: 1–90 m (but see comments), depending on dart size (1–25 ml) and propellant charge.

Operation: Choose dart and needle sizes based on amount of drug required and size of animal.

- Follow manufacturer's directions for loading darts (also see Darts below).
- Check that dart is not bent or deformed by inserting into the end of barrel. The dart should slide back and forth easily. If the dart sticks, discard it and reload another dart. Sticking darts tend to leave the barrel at much higher velocities and could cause injury to the animal.
- Load dart into breech; be sure safety is on (treat these guns like the firearms that they are!).
- Select powder charge (brown, green, yellow, red) and/or adjust variable range device.
- Aim at large muscle masses (Figure 2, Chapter 2).

Comments: Regardless of system used, always practice with the anticipated dart size at the anticipated ranges. Use darts loaded with water as opposed to empty darts in order to mimic actual weight and thus flight characteristics. The trajectory of most darts is characterized by a rapid drop during the final one third of the flight path and you should familiarize yourself with this phenomena prior to field use. Also, despite manufacturer's claims, the realistic maximum effective range is around 50 m.

- In .22-caliber guns, "green" charges are the most commonly used; "brown" charges may be too weak and the "red" charges are potentially too damaging to the animal regardless of range. Do not use blanks with wads in Pneu-Dart® guns because the wads will obstruct the gas ports. The .22-caliber guns should not be used at ranges < 10 m unless they are equipped with devices that meter the amount of gas delivered to the dart.
- Cold temperatures (<0° C/32° F) can render CO_2-powered guns almost useless; even cool temperatures can affect performance.
- Darts fired at high velocities can imbed in muscle, break bones, or kill the animal (Thomas and Marburger, 1964) – a word to the wise.
- Many drug preparations are corrosive to both metal darts and gun barrels – keep your equipment clean, even if you end up not firing the gun.

Darts

Darts can be thought of as "flying syringes," consisting essentially of a needle, body, plunger, and tailpiece. They differ in the manner in which the plunger is pushed forward to inject the dart's contents and in the materials of construction. Darts discharge their contents either by expanding gas from an explosive powder

charge, compressed air, vaporized gas (butane), chemical reaction (acid-base), or compressed spring (Figure 6). The mechanisms which enable the darts to discharge their contents upon impact range from moderately simple systems having few parts to complex systems of intricate design and operation. Dart bodies can be made of aluminum or synthetic polymer (polypropylene, polycarbonate, etc.). Dart tail designs range from elaborate fins molded from synthetic polymers to simple strands of yarn stuffed into the back of the dart.

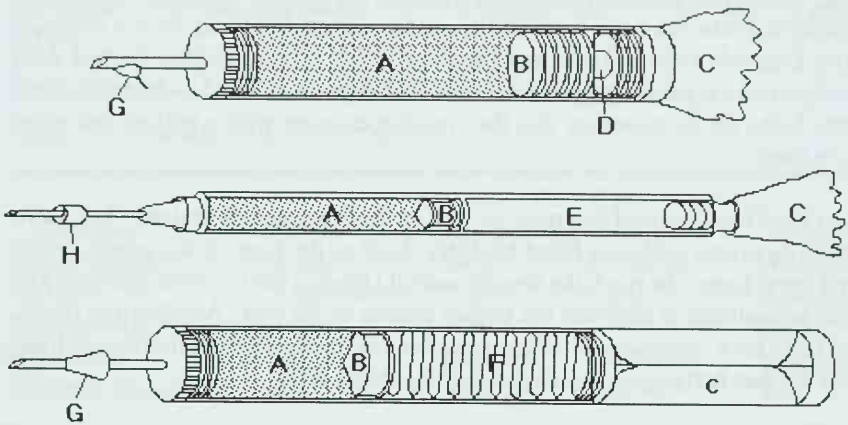

Figure 6. Schematic drawing of typical construction used in darts. A) drug chamber, B) movable plunger, C) tail piece, D) explosive charge, E) compressed air chamber, F) spring, G) barb, H) needle collar (slides back to discharge drug after dart penetrates skin).

Dart needles can be as long as 75 mm with a 2.16 mm inside diameter. Darts using explosive charges expel their contents in < 0.001 sec and thus require large-bore needles to allow the rapid expulsion of liquid. Needles are designed to either expel contents from the standard front opening (end port) or through a side port with the front opening occluded. End-port needles expel their contents more rapidly than do side-port needles, but large-bore needles can become plugged with a core of tissue when they penetrate hide and muscle (Henwood and Keep, 1989).

Needle shafts can either be smooth or be equipped with a variety of barbs or collars to retain the dart in the animal. Smooth-shafted needles are used to deliver the drug and then fall out on their own, eliminating the need to capture the animal to remove the dart. Such darts are commonly used to remotely treat, but not necessarily to capture, animals. If the dart contents are under high pressure, however, smooth-shafted needles can "rocket" back out of the animal due to the expulsion of the liquid and therefore not inject any or all of the substance.

Some needles are equipped with small collars that barely secure the dart in the

animal, but will eventually fall out on their own. One company (Pneu-Dart) manufactures a gelatin collar that is rigid when dry, but dissolves when it comes into contact with tissue fluids. This dart stays in the animal long enough to insure complete expulsion of the contents, but it will still fall out on its own at some later time.

To securely retain the dart in the animal, either spring barbs or metal collars are used. These darts require manual removal from the animal. Experimentation with retractable barbs has been successfully accomplished, but these are not commercially available (Van Rooyen and De Beer, 1973; Smuts, 1973). Barbed darts usually create a greater wound upon removal than do collared or barbless darts. Some barbs are so tenacious that they require excision with a scalpel just to remove them.

Darts have been devised that mark as well as treat the animals that they hit. Darts can be equipped with dye-filled bladders fixed to the base of the needle which burst upon impact to mark the treated animal (Bush, 1992). These bladders also serve as cushions to decrease the impact trauma of the dart. Another dart (Pneu-Dart) utilizes a "piggy-back" tailpiece containing the dye or paint that breaks loose from the dart body upon impact to spray the target area.

Darts have can also be equipped with small radio transmitters enabling location of animals that have run off after being darted with immobilizing drugs (Nielsen, 1982; Lawson and Melton, 1989). The effective transmitter range of these darts is usually < 300 m, but the growing technology of small transmitters that can withstand impact energy holds promise of extended ranges.

The advantages and disadvantages of each dart injection system are listed in Table 5. Again, this analysis is provided for those not familiar with the different dart characteristics and who might such information useful in selecting a dart type. The criteria analyzed for this table include:

Injection Speed
If injection speed is rapid (e.g., < 0.001 sec), tissue can be injured and absorption slowed. However, if injection speed is slow, the animal (e.g., carnivores) may have time to remove the dart before all the contents have injected.

Weight
Lightweight darts may cause less impact when they strike the animal (see Table 4), however, they may be more subject to wind drift and prop wash from helicopters.

Volume
This category lists the volumes capable of being delivered by each dart type.

Reliability
Dart types are rated based on consistency of injecting the entire dart contents.

Contents Under Pressure
This is a Yes/No rating only. The contents of some darts are pressurized when they are initially loaded. This type of dart is more prone to leaking or spraying its contents than darts which do not develop any expulsion pressure until they strike the animal. This potential hazard may be a consideration when using very potent drugs.

Table 5. Characteristics of dart types.

	Dart Type:			
Category	Powder	Compressed Air	Gas[a]	Spring
Injection Speed	Rapid	Slow	Moderate	Moderate
Weight	Light-Heavy	Light	Light	Medium
Volume (ml)	1-25	1-10	1-6	2-3
Reliability	High	Medium	Medium	Medium
Contents Pressurized	No	Yes	Yes/No[b]	Yes

[a]Gas can be from either butane or acid-base mixture.
[b]Gas darts may be pressurized prior to firing or develop gas pressure after striking the target.

Manufacturers: Dan-Inject, Palmer, Paxarms, Peter Ott Co., Pneu-Dart, Telinject
Specifications: Darts expel contents by compressed air, compressed spring, or powder charge. Dart bodies constructed primarily of plastic or aluminum.
Operation: *Powder Charge Darts (Cap-Chur®)* – Check that the aluminum dart body is not distorted from previous firings by inserting it into the end of the dart gun barrel and insuring that the dart body moves freely back and forth.

- Be sure that the inside of the dart body is clean. Lubricate the plunger with a good quality, water-resistant lubricant such as silicone. Move the plunger back and forth within the dart body to lubricate the body walls. Position the plunger with its open end all the way to the rear of the dart body.
- Insert the powder charge into the plunger base making sure that the movable striker in the charge *faces towards the rear* of the dart. The striker end of the powder charge can be determined by poking it slightly with a pen (or other pointed object) which causes the striker to move. Be sure that the powder charge matches the volume of dart body (i.e., 1–3 ml, 4–10 ml, etc.).
- Screw in the tail piece into the dart body which moves the plunger and its charge forward.
- Load the front of the dart with the desired volume of drug. The drug level should just reach the bottom of the screw threads at the front of the dart body; if the

drug volume does not reach this point, top off with sterile water.

- Screw in the appropriate-sized needle for the target animal; the larger the animal, the larger the needle length (but use good sense and knowledge of your animal's anatomy for exceptions to this rule).
- Although the vacuum formed by the fluid in the dart body should prevent any drug from leaking out of the needle (even when held upside down), jarring the dart has been known to spill drug. If this could be a problem, seal the needle opening with petroleum jelly.

Pneu-Dart ®Darts – These darts are single-use darts using either a powder charge or an acid-base mixture to expel the dart's contents. The acid-base darts mix only after the dart strikes the animal and they have a slower injection time than do the powder charged darts. In either case, these darts are loaded through the needle since the darts are of one-piece construction.

- Withdraw the desired drug volume in a syringe. It is important to load these darts *using a needle that is longer than the dart needle*. This loading needle must be small enough to fit within the inside diameter of the dart needle; usually a 1.5–2.0 inch, 18-gauge needle works fine for this. If the loading needle is shorter that the dart needle, drug will be expelled back out of the dart needle.
- Using the loading syringe, slowly push the drug into the dart body. Again, if the drug volume is less than the dart volume, top off with sterile water.
- The needle can be plugged with petroleum jelly to prevent any possible leakage, if desired.
- Older Pneu-Dart® darts had a safety wire wrapped around the tailpiece. This wire *must be removed* prior to loading into the dart gun or else the dart will not discharge its contents upon impact.

Compressed Air Darts (Dan-Inject, Telinject) – These darts can be thought of as two syringes joined at their bases. Each half has a plunger; one that is readily movable and another that seals against the syringe walls and is used to deliver the drug. The half with the freely movable plunger is the rear portion of the dart.

- If the plunger in the front chamber is all the way forward, hold the dart upside down so that the movable plunger falls forward and inject air into the front end of the dart using an empty syringe fitted with a coupling device. The injected air moves the front plunger into the appropriate position for the amount of drug being delivered. For example, you can push the plunger to the 2-ml mark in a 3-ml dart.
- Load the front portion of the dart with the desired drug volume, insuring that the drug fills the chamber (again, use sterile water to top off).
- Firmly attach the dart needle.
- Occlude either the end of the needle or its side port, as appropriate, with the needle plug supplied.
- Insert the front of the dart into a container, such as a test tube, to contain any accidental spraying of drug when the dart is being charged.
- Holding the dart with the needle pointing up, insure that the movable plunger falls to the bottom of the rear chamber.

- Pull back the plunger on an empty 10–20 ml syringe fitted with the coupling device and attach this syringe to the rear of the dart.
- Compress the syringe's air into the dart; the movable plunger will seal the rear opening of the dart as air pressure builds up in the rear chamber.
- When there is firm resistance on the plunger of the syringe loaded with air, quickly remove the syringe from the dart.
- Attach the dart's tailpiece.
- Carefully check the dart needle for any sign of leakage.
- Oftentimes, there is a little air bubble in the front drug chamber which will be compressed or disappear when the dart has been properly charged, thus providing a handy visual cue as to the dart's readiness.
- Keep the dart stored in a tube until just prior to loading in a blow pipe or dart gun.

Comments: Dart contents injected by butane gas may be less reliable in cold weather; on the other hand, unvaporized gas remains in the liquid state prior to discharge which provides a visible check on the dart's readiness.

- Some dart needles discharge from the end and others from the side port. End-port needles discharge rapidly but they must strike the animal almost perpendicularly in order to stick. This is due to the end being capped by a silicone plug, which acts as a "bumper" should the dart strike at an angle. Side-port needles slide the silicone plug up the shaft to cover the opening, thus exposing the sharp needle tip and increasing the probability of the dart penetrating, even when striking at an angle (Figure 7). Side-port units inject their contents more slowly than end-port needles.
- Use sterilized dart needles (store in alcohol or commercial solution or autoclave and securely wrap).
- Darts which employ a powder charge to expel dart contents do so very rapidly (< 0.001 sec) often resulting in severe tissue damage. There is much empirical evidence that drug absorption from these darts can be slowed resulting in prolonged induction times.
- If possible, flush injection site with diluted povidone-iodine (10%) or chlorhexidine diacetate (0.05%) solution. Antibiotic "teat tubes" used to treat mastitis in dairy cows can be useful for treating dart wounds since they are equipped with a rounded, plastic "needle" that can be safely inserted into the dart hole.

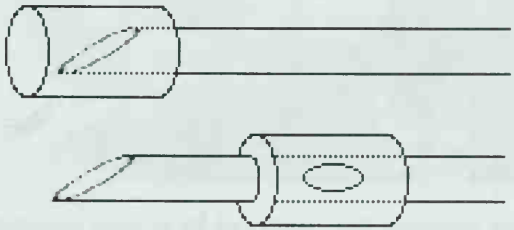

Figure 7. Dart needles occluded by sleeve either at end (top) or over side port (bottom).

Regardless if the dart wound can be treated or not, all animals being struck by a dart should be given an appropriate dose of antibiotic, such as penicillinase-resistant penicillins, cephalosporins, tetracyclines, or trimethoprim-sulfadiazine.

Monitoring Equipment

Thermometer

Many immobilizing agents disrupt an animal's thermoregulatory capability. Additionally, the physical exertion of being chased or restrained prior to immobilization often results in elevated body temperatures. Either hyper- or hypothermia can kill an animal. Thus, monitoring rectal temperatures is important. The glass mercury thermometer is basic equipment, although readings are slow to develop and they are prone to breakage. Inexpensive, electronic thermometers sold in human drug stores are rapid and accurate, but batteries have a habit of expiring at the most inopportune moments. They are generally not moisture resistant. Some types have a long, flexible temperature probe which allows greater probe insertion for large animals or protection of the electronics box by placing it away from the animal (Figure 8).

Pulse Oximeter

Pulse oximeters are electronic devices that measure the percent oxygen saturation

Figure 8. Immobilized mountain lion monitored by a pulse oximeter (left), vital signs monitor (center), and electronic thermometer (right).

of hemoglobin in the blood (SpO_2). As such, they provide information on the respiratory function of the animal which can be useful because many immobilizing drugs depress respiration. Some oximeters are small, portable, and battery-powered and thus can be used in the field.

Oximeters use a clip that can be attached to the tongue (Figure 8) or other thin, non-pigmented tissue or a rectal probe to measure SpO_2. The SpO_2 is determined by passing two wavelengths of light, one red and one infrared, through body tissue to a photodetector. The oximeter processes these signals, separating the time invariant parameters (tissue thickness, skin color, light intensity, and venous blood) from the time variant parameters (arterial blood and SpO_2). Because oxygen-saturated blood predictably absorbs less red light than oxygen-depleted blood, oxygen saturation (as well as the pulse) can be calculated.

In human medicine, patients are monitored with oximeters while anesthetized and they are usually given supplemental oxygen when the SpO_2 falls below 90% in order to insure adequate oxygenation of tissue (particularly of the central nervous system). This "90%" rule is usually employed for anesthetized animals when oxygen supplementation is available; however, many times oxygen is simply not available. It is also not uncommon for animals anesthetized with potent narcotics or alpha$_2$-adrenergic agonists to have SpO_2 values that fall markedly below 90%. However, there currently are no data on the pathological effects, if any, of depressed SpO_2 values in wild animals and we are left to speculate if absolute SpO_2 values have any biological significance to the immobilized animal. Nonetheless, the *trend* of SpO_2 values do have value. That is, if the SpO_2 steadily decreases, it can be presumed that the animal is in some sort of respiratory crisis. Such decreases have been used to detect severely compromised respiration due to pneumothorax in a wolf, bloat in an elk, and isoflurane overdose in a black-footed ferret (Kreeger, unpubl. data).

Vital Signs Monitor

In unusual situations or when immobilizing particularly critical animals, monitoring cardiac function may be required. Additionally, such information may be useful when evaluating a new drug. Portable, rechargeable, vital signs monitors, primarily designed for human emergency use, have been successfully adapted for use on a variety of birds and mammals. Some of these units can simultaneously display electrocardiogram (ECG), systolic/diastolic/mean arterial blood pressure, as well as body/skin temperature (Figure 8).

Equipment and Supply Checklist

- Dart guns (.22-caliber, CO_2, or compressed air)
  - .22 charges (brown, green, yellow, red)
  - CO_2 propellant
  - Shotgun cleaning rod (to remove stuck or unused darts)
  - Extra batteries for electronic sights
- Re-usable Powder Charge Darts
  - Dart bodies (1, 2, 3, 5, 7 ml)
  - Dart charges (1–3, 4–10 ml; keep dry)
  - Dart needles
  - Dart plungers
  - Dart tailpieces
  - Silicone lubricant (for dart plungers)
  - Rod for pushing plunger through dart to lube
  - Extra .22 adapters for Cap-Chur® guns
- Disposable Darts (powder and/or acid-base charged; 1, 2, 3, 5 ml)
- Compressed Air Darts
  - Darts (2, 3, 5 ml)
  - Dart needle sleeves or caps
  - Tailpieces
  - Coupler
  - 20 ml syringe
  - Plunger rod (for discharging reservoir)
- Pole Syringe
  - Extra syringe barrels, parts
- Petroleum Jelly
- Marking pen, pencil
- Needles (25 ga x 0.75", 20 ga x 1", 18 ga x 1", 18 ga x 1.5", 16 ga x 1", 16 ga x 1.5")
- Syringes (1, 3, 5–6, 10–12, 20 ml)
- Blood collection tubes (with and without anticoagulant)
- Swiss Army™ knife/Leatherman™
- Pliers
- Cigar tubes (or other device to safely store loaded darts until used)
- Sterile water (for topping off darts)
- Propylene glycol (mix with drugs to act as antifreeze)
- Scalpel blades (for removing barbed darts)
- Flashlight (plus extra bulb and batteries)

List of Manufacturers and Major Distributors

Advanced Injection Systems
705 North Fourth St.
P.O. Box 1001
St. Joseph, IL 61873 USA
Tel: 217-469-2690
(Dart guns, pole syringes)

Animal Care Equipment and Services, Inc.
613 Leebert Way
Crestline, CA 92325 USA
Tel: 909-338-1791
(Distributor of animal capture equipment)

Animal Management Inc.
720 Eppley Road
Mechanicsburg, PA 17055-9786 USA
Tel: 800-745-8173
(Distributor of animal capture equipment)

Dist-Inject
Peter Ott AG
Vet. Med. Gerate und Pharmazeutica
Postfach, CH 4007
Basel, Switzerland
Tel: 061 6923442
(Dart guns, darts, blow pipes)

Palmer Chemical & Equipment Co., Inc.
P.O. Box 867
Palmer Village
Douglasville, GA 30133 USA
Tel: 404-942-4395
(Dart guns, darts)

Paxarms Limited
Dr. Andrew A. McKenzie
Wildlife Decision Support Services
Box 73528
Lynnwood Ridge, 0040 RSA
(Dart guns, darts, pole syringes)

Pneu Dart, Inc.
P.O. Box 1415
Williamsport, PA 17703 USA
Tel: 717-323-2710
(Dart guns, darts)

Telinject USA, Inc.
9316 Soledad Canyon Road
Saugus, CA 91350 USA
Tel: 805-268-0915
(Dart guns, darts, blow pipes)

Vermin Control + Tranquil-Inject Ltd.
P.O. Box 370
Reading RG4 7LL
Berks, UK
Tel: 0734 461141
(Dart guns, darts)

Wildlife Pharmaceuticals, Inc.
1401 Duff Drive
Suite 600
Fort Collins, CO 80524 USA
Tel: 970-484-6267
(Dart guns, darts, blow pipes, pole syringes)

Wiley & Sons, Inc.
Rte. 1 Box 303
Wills Point, TX 75169 USA
Tel: 903-848-7912)
(Distributor of animal capture equipment)

Zoolu Arms of Omaha
10315 Wright Street
Omaha, NE 68124 USA
(Dart guns, darts, blow pipes, pole syringes)

Emergency Treatment - Animal

Quick Reference Guide to Animal Emergencies

This section is not intended to be a comprehensive course on veterinary emergency medicine. Rather it is intended to familiarize you with the most common medical emergencies encountered in the chemical immobilization of wild animals. The list of possible complications is lengthy, but the majority of problems are concerned with TPR - Temperature, Pulse, Respiration. This chapter is also writ-

ten with the assumption that many immobilizations are conducted in the field where monitoring and emergency equipment will be minimal. Thus, your ability to assess problems will be limited to what you can see, hear, or feel. This manual cannot teach techniques, such as inserting an endotracheal tube. Although such techniques may be recommended, if you are unfamiliar with them, you should receive training from an experienced individual before trying them. The below order is based on the probability of occurrence as well as necessity for immediate action. Contents of a minimal veterinary first aid kit are included at the end of this chapter for your information and to aid in selection of emergency equipment and supplies.

Respiratory Depression or Arrest

Definition:

Tissue hypoxia resulting in cell death or damage caused by inadequate oxygenation of blood hemoglobin.

Causes:

- Drug-induced depression of respiratory center
- Airway obstruction
  - nose, trunk occluded
  - trachea occluded (neck draped over log, neck twisted, etc.)
  - vomitus blocking airway
  - edema blocking airway
- Pressure on the diaphragm
  - bloat
  - intestinal contents

Signs:

- Few or no respirations
- Cyanosis - gums blue, gray, or "muddy"
- Noisy breathing, wheezing, rattling
- Oxygen saturation (measured via pulse oximeter) < 70% for more than 2 minutes or oxygen saturation trend is continually downwards.

Treatment:

1. Cease all further administration of immobilizing drugs.

2. Establish patent airway.

Insure that neck is straight, tongue pulled out, trachea clear of vomitus, foreign objects, etc. Position animal correctly; ruminants should be placed on their *right* sides or on their sternums (elephants should always be on their sides).

3. Begin artificial ventilation.

Manual chest compression can be performed on animals up to 200 kg by laying the animal on its side and pushing down firmly on the chest, 15-20 times per minute (Figure 9). For larger animals, you can try folding, then raising and pulling forward on its front legs in a pumping motion OR

- mouth-to-mouth or mouth-to-nose resuscitation OR
- insert endotracheal tube and ventilate with air (from mouth, resuscitation bag) or from oxygen supply OR
- attempt tracheotomy if laryngeal area is hopelessly blocked.

After artificial ventilation has returned normal color to mucous membranes (gums pinkish), stop ventilation for at least one minute to see if the animal will begin breathing on its own. If no respirations are noted, resume ventilation, stopping periodically to allow the animal to breathe without your intervention.

4. Administer 1-2 mg/kg doxapram (Dopram®) IV.

Give doxapram only if artificial resuscitation did not cause the animal to start breathing on its own.

5. Administer appropriate antagonist IV.

If artificial resuscitation or doxapram did not cause the animal to start breathing on its own, your next recourse is to antagonize the immobilizing drugs, even though it means that the animal must be released. If you cannot hit a vein within 30 seconds

Figure 9. Artificial ventilation of a mountain lion demonstrating position of hands over thorax.

split the dose and give the antagonist in two sites in the shoulder or hip muscles:

- Etorphine: administer 2 mg diprenorphine (or 20 mg naloxone or naltrexone) for every mg of etorphine given.
- Carfentanil: administer 100 mg naltrexone or naloxone for every mg carfentanil given.
- Xylazine: administer 0.125 mg/kg yohimbine.
- Medetomidine or detomidine: administer 5 mg atipamezole for every mg of medetomidine or detomidine given.

Comments:

Respiratory depression/arrest is probably the most common complication encountered in wild animal immobilization. The best advice I can give concerning respiratory arrest is not to panic. You probably have up to 5 minutes before irreversible, hypoxic brain damage occurs. This is really a very long time in which to take corrective action. Panic serves only to confuse your thinking and diffuse your efforts – both of which cost the animal time.

Hyperthermia

Definition:

Body temperature increases to point where oxygen demand exceeds supply due to increased metabolism.

Causes:

- Metabolic heat generated by physical exertion
- Heat absorption from environment
  - warm ambient temperatures, direct exposure to sun
  - confinement in poorly ventilated space
- Drug-induced alteration of thermoregulatory centers
- Bacterial infection

Signs:

- Elevated rectal temperature (> 40° C/104° F)
- Extremities (ears, feet) very warm to the touch
- Rapid, shallow breathing
- Rapid heart rate, irregular pulse
- Coma, death

Treatment:

1. Cease all further administration of immobilizing drugs.

2. Cool the animal.

First move the animal out of direct sunlight, if possible. Then employ one or more

of the following methods to cool the animal. Whole body immersion in water is probably the most rapid means of decreasing the temperature.

- immerse animal in water (pond, stream, water tank)
- spray entire animal with water, particularly the groin and belly
- pack ice or cold water bags on groin, head
- douse with isopropyl alcohol (rapid evaporation cools quicker)
- administer cold water enema
- administer cold lactated Ringer's solution IV or IP (also see Dehydration)

3. Administer appropriate antagonist IV.

Immobilizing drugs not only disrupt the thermoregulatory center, but they prevent the animal from using its normal cooling mechanisms such as sweating and panting. If the above cooling steps did not lower the animal's temperature, your next recourse is to antagonize the immobilizing drugs even though it means that the animal must be released. If you cannot hit a vein within 30 seconds, split the dose and give the antagonist in two sites in the shoulder or hip muscles:

- Etorphine: administer 2 mg diprenorphine (or 20 mg naloxone or naltrexone) for every mg of etorphine given.
- Carfentanil: administer 100 mg naltrexone or naloxone for every mg carfentanil given.
- Xylazine: administer 0.125 mg/kg yohimbine.
- Medetomidine or detomidine: administer 5 mg atipamezole for every mg of medetomidine or detomidine given.

Comments:

Severe hyperthermia (> 41° C/106° F) is a medical emergency and you must cool the animal immediately. Obtaining a rectal temperature should be one of the first steps taken as soon as the animal can be safely handled. Monitor the temperature throughout the immobilization period.

Hypothermia/Frostbite

Definition:

Decreased body temperature to point of cellular death due to decreased metabolism, freezing of cellular water, and/or vascular damage.

Causes:

- Drug-induced
  - decreased metabolism and/or endogenous heat production
  - alteration of thermoregulatory center
- Cold ambient temperature
- Loss of insulation
  - wet, soaked coat

- oiled fur or feathers
- malnourished (decreased fat)
- recumbent in one position for too long (compresses downside fur)

- Inadequate circulation
  - shock
  - foothold trap

Signs:

- Decreased rectal temperature (< 35° C/95° F)
- Shivering
- Decreased heart rate
- Decreased blood pressure (pulse difficult to feel)
- Extremities cold to touch
- Extremities firm (frostbite)

Treatment:

1. Warm the animal.

The only treatment for hypothermia or frostbite is warming the animal or affected part. One or more of the below methods can be employed to accomplish this. Regardless of the method(s) used, expect a slow recovery back to temperatures suitable for release of the animal (38° C/100° F).

- *containers* of warm water (do not wet the animal unless you can dry it also!)
- blankets
- foam pads (place under animal)
- hand warmers
- body heat (put small animal inside of your coat)
- electric heat pads, lights

Comments:

Antagonism of immobilizing drugs is *not* recommended for hypothermia cases. This is because recovery is invariably slow and if you release the animal with depressed temperature, it may walk away appearing normal only to succumb to hypothermia later because it was unable to produce enough endogenous heat to rewarm itself. You may actually have to give boosters of immobilizing drugs to keep the animal unconscious until warmed. However, because the animal's metabolism is slowed by the hypothermia, drug effect is usually prolonged and recovery will be slow anyway. Chilling below 24° C/75° F invariably results in irreversible recovery and death. Hypothermia is not as common of a problem as is hyperthermia. Because of this, many overlook this problem in the field - much to their chagrin. Very cold weather (< -18° C/0° F) is hard on animals, people, and equipment.

Shock

Definition:
Shock is a clinical syndrome characterized by ineffective blood perfusion of tissues resulting in cellular hypoxia. Shock is often seen in animals which have undergone a stressful or strenuous capture or handling.

Causes:
- Prolonged physical exertion
- Prolonged physiological and/or psychological stress
- Severe blood loss

Signs:
- Rapid heart rate
- Low blood pressure (slow capillary refill)
- Muscle weakness
- Depressed sensorium (often masked by drugs)
- Hyperventilation

Treatment:
1. Cease all further administration of immobilizing drugs.

2. Administer 30 ml/kg Lactated Ringer's solution IV.
If shock is due to blood loss or redistribution of blood, administer lactated Ringer's solution IV rapidly by using a large-bore (16-18-gauge) needle into a large vein such as the jugular or femoral. Infusion of fluids works best with a drip set attached to the fluids bag, but you could also use a large-capacity syringe (30-60 ml) by leaving the needle in the vein, removing only the syringe to refill, and reattaching the syringe to the needle to administer the fluids. Administering fluids to large animals may be impractical due to the amount of fluid required (often several liters). Needless to say, if blood loss is due to a wound, the wound must be corrected as well.

3. Administer 5 mg/kg dexamethasone IV.
Administer slowly (app. 30 sec). Prednisolone sodium succinate at 10 mg/kg IV or methylprednisolone sodium succinate at 20 mg/kg IV can be substituted for dexamethasone.

4. Assist ventilation if necessary.

Comments:
Many deaths of captured animals are attributed to stress or shock but a definitive diagnosis often remains open. Like capture myopathy, there may be little that you can do to treat shock, except prevent it from happening in the first place.

Bloat

Definition:
Excess gas resulting from normal fermentation accumulating in the rumen of ungulates; the rumen enlarges compressing the diaphragm and lungs and impairing respiration.

Causes:
- Drug-induced (xylazine, opioids)
- Incorrect body position

Signs:
- Increase in size of abdomen
- Labored breathing (rapid, shallow)
- Increased salivation

Treatment:
1. Correct body position (sternal or right side down).
Hold head up to straighten esophagus. Elephants should be on their sides.

2. Pass stomach tube.
A fairly flexible, plastic tube (48" long x 5/8" O.D.), inserted through the esophagus into the stomach, can relieve bloat by releasing intestinal gas. Lubricate the tube with K-Y jelly and be sure that there are no sharp edges on the tube that could lacerate tissue. Be sure you are not in the trachea! If you are not sure about the placement of the tube, listen to the end of it for breathing sounds. Also, the animal will oftentimes cough if the tube is placed into the trachea.

3. Insert large-bore needle into left flank to release gas.
If you don't have a stomach tube or can't otherwise relieve the bloat, place the animal right side down. Next, locate the highest point of the bloated rumen (which will be on the left or upper side); this essentially will be the tallest point of the animal's side if it is lying on a flat surface. Insert a 16- or 18-gauge, 1.5-inch needle straight into the rumen at this point. You should be able to hear and smell escaping rumen gas. This method is slower than a stomach tube, so continue to monitor breathing until the bloat is relieved.

4. Administer appropriate antagonist IV.
If the above steps did not relieve the bloat or if a respiratory crisis develops, your only recourse is to antagonize the immobilizing drugs even though it means that the animal must be released. Antagonism of the immobilizing drugs should allow the animal to eructate on its own to relieve the bloat. If you cannot hit a vein within 30 seconds, split the dose and give the antagonist in two sites in the shoulder or hip muscles:

- Etorphine: administer 2 mg diprenorphine (or 20 mg naloxone or naltrexone) for every mg of etorphine given.
- Carfentanil: administer 100 mg naltrexone or naloxone for every mg carfentanil given.
- Xylazine: administer 0.125 mg/kg yohimbine.
- Medetomidine or detomidine: administer 5 mg atipamezole for every mg of medetomidine or detomidine given.

Comments:
A stomach tube should be standard equipment when immobilizing ruminants because bloat is a common sequelae to chemical immobilization. Often however, you will be through with the procedure and will have antagonized the immobilizing drugs before bloat develops to the point of causing complications.

Vomiting/Aspiration

Definition:
Vomiting is the ejection of stomach contents through the esophagus and mouth; aspiration is the inspiratory sucking into the airways of foreign material, such as vomitus.

Causes:
- Drug-induced (e.g., xylazine)
- Stress, excitement
- Head positioned lower than stomach/rumen

Signs (aspiration):
- Gurgling sounds during respiration
- Choking, gasping
- Cyanosis - gums blue, gray, or "muddy"
- Presence of foreign material in larynx, trachea
- Respiratory arrest

Treatment:
1. Cease all further administration of immobilizing drugs.

2. Clear airway.
Clear vomitus, mucus, etc. as much as possible. Place the animal on its sternum with its neck down and head extended and then lift the body with head and neck remaining down, if possible, to help clear vomitus. Smaller animals can be suspended by their rear legs and shaken up and down slightly.

3. Begin artificial ventilation, if necessary.

If breathing has ceased, use one of the below methods to induce the animal to begin breathing on its own:

- Manual chest compression can be performed on animals up to 200 kg by laying the animal on its side and pushing down firmly on the chest, 15-20 times per minute. For larger animals, you can try folding, then raising and pulling forward on its front legs in a pumping motion OR
- mouth-to-mouth or mouth-to-nose resuscitation OR
- insert endotracheal tube and ventilate with air (from mouth, resuscitation bag) or from oxygen supply OR
- attempt tracheotomy if laryngeal area is hopelessly blocked.

4. Administer 1-2 mg/kg doxapram (Dopram®) IV.

Give doxapram only if artificial resuscitation did not cause the animal to start breathing on its own.

5. Administer long-term antibiotics.

Aspiration of vomitus can result in the development of pneumonia (see comments).

Comments:

Vomiting in and of itself generally is not a problem; the aspiration of the vomitus is. Not only can the animal choke on the vomit and die, the mere aspiration of just a small amount of stomach contents can inoculate the lungs with bacteria resulting in pneumonia. The pneumonia won't develop for days - long after the animal has been released and oftentimes beyond further treatment. Thus, aspiration may result in the delayed death of the animal even though at the time of recovery it seemed perfectly healthy. Aspiration of large amounts of vomitus has a grim prognosis for the animal and euthanasia may be considered.

Capture Myopathy

Definition:

Capture myopathy (CM) is a complex condition affecting animals which usually have undergone a particularly stressful or strenuous capture or handling. The pathophysiology of CM is complex and I refer you to Spraker (1982, 1993) for an excellent discussion of this topic.

Causes:

- Prolonged physical exertion
- Prolonged physiological and/or psychological stress

Signs:
- Ataxia, weakness
- Paresis or paralysis
- Myoglobinuria (dark, brownish urine)
- Death

Treatment:
1. Administer 5 meq/kg sodium bicarbonate IV.
Administer slowly (4–5 ml/min) to avoid cardiac arrhythmias.

Comments:
Because the pathogenesis of CM is incompletely understood, treatment is difficult and often unsuccessful. There is nominal consensus that lactic acidosis (lowered blood pH) is a consistent finding in CM cases. Restoration of normal blood pH by the administration of sodium bicarbonate is thought to ameliorate much of the pathology associated with CM. Signs of CM may develop within a few hours of capture or may not appear for several days. Blood samples will show severely altered serum chemical values; necropsy of the hindquarters often reveals gross or microscopic muscle degeneration. Capture myopathy occurs predominantly in ungulates, but it has also been reported in primates, birds, marsupials, seals, raccoons, and dogs. Animals deficient in vitamin E and selenium may be more likely to develop CM.

Seizures/Convulsions

Definition:
Transient disturbance of cerebral function characterized by a violent, involuntary contraction or series of contractions of the voluntary muscles.

Causes:
- Drug-induced (e.g., ketamine or ketamine combinations)
- Trauma
- Hypoglycemia

Signs:
- Uncontrolled muscle spasms; whole body spasms
- Rigid extension of the limbs
- Mouth gaping

Treatment:
1. Administer 10 mg diazepam (Valium®) IV slowly.
Administer the diazepam dose IV over a 10–15 second interval to prevent cardiac arrest due to a rapid IV bolus. Midazolam (Versed®) can be substituted for diazepam

at the same dose. Midazolam does not have to be injected slowly. Both diazepam and midazolam can be given IM. Repeat dose if animal continues to seizure.

2. Monitor temperature.
Prolonged seizures can increase body temperature due to endogenous heat production. If temperature > 41° C/105° F, refer to treatment of hyperthermia.

Comments:
Most seizures seen in chemical immobilization are due to the use of ketamine or phencyclidine, either when used alone or in conjunction with the alpha-adrenergic or phenothiazine tranquilizers. Usually, seizures do no harm to the animal, but they disrupt handling of the animal and can lead to hyperthermia and other complications if left untreated. Seizures accompanying ketamine/phencyclidine immobilizations are most common during induction into and recovery from anesthesia.

Wounds

Treatment:
1. Clean the wound.
Small, shallow lacerations can be lavaged with a povidone-iodine (Betadine®), 2% chlorhexidine (Nolvasan®) scrub solution, or sterile saline. Deeper, penetrating wounds can be flushed by diluting povidone-iodine with sterile saline to a 10% solution or 2% chlohexidine to a 0.05% (i.e., 1:40 dilution of the 2% solution) solution. If necessary, use a scalpel to cut away (debride) heavily damaged, diseased, or contaminated tissue.

2. Suture the wound, if necessary.
Generally, deep, penetrating wounds should *not* be sutured to allow drainage; lengthy lacerations, deep or shallow, should probably be sutured. Despite the fondness of some "old hands" to suture wounds with black thread or monofilament fishing line, there really is a rationale for using the different types of suture materials, needles, and patterns. For more information, you should consult surgery textbooks, or better, obtain first-hand experience with a veterinarian. Nonetheless, the situation is somewhat simplified under field situations. Although it is generally preferred to use *non*-absorbable sutures to close the outer skin layer and absorbable sutures for all internal layers, in the field you only need absorbable sutures for all closures since you will be releasing the animal (there is little likelihood that you could recapture the animal to remove any non-absorbable skin sutures!).

If the wound is deep, suture the internal muscle layers first using a tapered needle; then suture the skin using a "cutting" needle. It can be difficult, if not impossible,

to suture skin using tapered needles, so be sure that you are at least equipped with cutting needles.

3. Give antibiotics.

Any animal receiving a laceration should be given antibiotics to reduce the magnitude of infection. The penicillins are the most commonly-used antibiotics since they are effective against many of the skin microbes as well as formulated in repository (long-lasting) preparations. A combination of procaine penicillin G and benzathine penicillin G provides both fast, high blood concentrations (procaine) plus prolonged therapeutic concentrations (benzathine; 5-7 days). The minimum dose should be 22,000 IU/kg (10,000 IU/lb) of the *benzathine* penicillin G in order to obtain the repository effect. That is, if a penicillin combination contains 300,000 IU/ml of both penicillin types, then there is 150,000 IU/ml of the benzathine penicillin G. A 100-kg (220 lb) animal would be given (100 kg x 22,000 IU/kg)/ 150,000 IU/ml = 14.6 ml of the combined antibiotic. This should be administered with a large-bore needle (18 ga) IM at *no more* than 5 ml per injection site. Inject penicillin subcutaneously (SQ) or in the large muscle masses of the proximal hind limbs (i.e., hip muscles).

Antibiotics should also be given to animals which have been darted, particularly with the powder-charged darts. The large-bore dart needles often can inoculate surface bacteria resulting in debilitating abscesses. The dose would be the same as the above dose for treating wounds. It is also helpful to have intermammary infusion tubes in your veterinary kit. These are essentially disposable syringes, prefilled with antibiotics, and equipped with a rounded, plastic "needle" used to treat mastitis in dairy cattle. Insert the needle into the dart wound and squeeze the tube until antibiotic comes back out of the wound.

Cardiac Arrest

Definition:

Loss of effective cardiac function resulting in cessation of circulation.

Causes:

- Drug-induced
- Hypoxia (respiratory failure)
- Acid-base imbalance
  - acidosis
  - alkalosis
- Electrolyte imbalance
  - hyperkalemia
  - hypokalemia
  - hypocalcemia

- Autonomic nervous system imbalance
  - increased sympathetic tone
  - increased parasympathetic tone
- Hypothermia

Signs:
- Weak or absent heart sounds or pulse
- Poor capillary refill (> 2 sec - see comments)
- Cyanosis - gums blue, gray, or "muddy"
- Increased respiratory rate, abnormal pattern, or apnea
- Dilated pupils
- Skin cold
- Loss of consciousness

Treatment:

1. Cease all further administration of immobilizing drugs.

2. Be sure that the animal can breathe.
   - head and neck in proper position
   - no airway obstructions
   - begin artificial respiration (see Respiratory Arrest) if apneic
   - administer doxapram (Dopram) 1-2 mg/kg IV if apneic

3. Begin external cardiac massage.

Place the animal on its side and apply pressure downward over the heart. Compress for a count of 1 and release for a count of 1 with 60-100 cycles/min. An assistant should palpate the femoral pulse while cardiac massage is being performed to make sure that an effective wave is being produced.

4. Inject 0.2 mg/kg of 1:10,000 epinephrine intravenously IV or intracardially (IC) and continue massage.

For IC injection, you may need a long needle (2-3 in) to hit the heart. Insert the needle between the 4th to 6th ribs (usually above and slightly behind the point of the elbow), pull back on the plunger to withdraw blood from the heart to confirm that you are in the heart (or at least a major vessel), and inject. Use a stethoscope to monitor the heart.

Note: many epinephrine concentrations come as 1:1,000; you should dilute each ml of this solution with 9 ml of physiological saline or lactated Ringer's solution before administering IV or IC.

5. *If no response to the above,* inject 0.1 ml/kg calcium chloride solution (10% or 100 mg/ml) IV or IC.

Calcium gluconate (10%) solution can be substituted for calcium chloride solution.

6. *If still no response to the above,* repeat epinephrine and calcium chloride doses *plus* inject 10-20 mEq sodium bicarbonate IV or IC.

Comments:
Capillary refill time (CRT) is a method to assess peripheral perfusion and, by inference, cardiac function. To evaluate CRT, locate a non-pigmented (i.e., pink) area on the gums, vulva, inner eyelid, etc. of the animal (Figure 10). Apply pressure to this site with your finger and the compressed area will turn pale due to blockage of blood circulation. Release finger pressure and time (by counting one-one thousand, etc.) how long it takes for the bloodless area to turn pink again as blood perfusion is restored. A CRT of < 2 sec generally implies adequate blood pressure. A slower refill time indicates low blood pressure or other circulatory dysfunction.

The ideal method of cardiac dysfunction diagnosis and treatment is far more complex than presented here and in most field situations, you'll probably neither have time nor materials to follow a highly-complex treatment protocol. In the field, I have successfully revived heart function with cardiac massage and one or more epinephrine injections, but no other drugs. Those interested in a more detailed discussion of cardiac emergencies should consult an emergency treatment manual such as the *Handbook of Veterinary Procedures and Emergency Treatment* by S. I. Bistner and R. B. Ford (1995, W. B. Saunders). The occurrence of cardiac arrest in

Figure 10. Assessing capillary refill time (CRT) by depressing a non-pigmented part of the gum, releasing pressure, and determining time to restoration of color.

animal immobilization is fortunately rare, since odds are against pulling the animal through under field conditions.

Many cardiac problems do not arise directly from drug use but from metabolic disturbances due to extreme physical exertion and stress. The addition of drugs to a compromised physiological system often precipitates a crisis. Without an electrocardiogram or trained ear (auscultation), cardiac arrhythmias are difficult to detect or diagnose. However, many arrhythmias are probably benign in that they apparently do no long-term harm to the animal upon recovery. Again, consult the above reference if more information is desired on cardiac arrhythmias.

Dehydration

Definition:
Reduction of the body's water content

Causes:
- Decreased water intake
- Hyperthermia (increased loss of water by transpiration)
- Fever (increased loss of water by transpiration)
- Chronic vomiting
- Chronic diarrhea
- Wound drainage
- Polyuria (excessive urination)

Signs:
- Skin lacks pliability (see comments)
- Mouth, gums dry or tacky
- Weak pulse
- Depressed sensorium (may be masked by drugs)
- Signs of shock

Treatment:
1. Cease all further administration of immobilizing drugs.
Administer additional drugs to keep the animal immobilized only if necessary to initiate or maintain treatment. Often, the animal may be so depressed that additional drugs will not be necessary.

2. Determine the volume deficit (4-6-8-10 rule).
The loss of 4% of the body weight in fluid can be determined simply by a history of fluid loss (e.g., held in trap or pen without water for several hours in warm weather, etc.). A 100-kg animal with a 4% loss would have a volume deficit of 4 liters (100 kg x 0.04 = 4 kg = 4 liters fluid).

An animal losing about 6% of its fluid volume would have obvious fluid deficits. The mucosa of the mouth would be red and dry; the skin would be tacky and not pliable (see comments). As before, a 100-kg animal with a 6% loss would have a volume deficit of 6 liters.

A loss of 8% fluid volume represents severe fluid loss. The pulse would be weak and the animal depressed. A ≥ 10% fluid loss is life threatening and the signs are those of shock.

3. Administer fluid therapy.

Use the 4-6-8-10 rule above to calculate the amount of fluids required. Administer isotonic lactated Ringer's solution or 0.9% saline either IV, SQ, or IP.

Comments:

One of the quickest methods of diagnosing clinical dehydration in the field is to pinch the animal's skin forming a "tent." If the animal is well hydrated, the skin tent will collapse to its normal configuration almost instantly. If the tent collapses relative slowly (e.g., 1-2 sec), you can assume that the animal is dehydrated. If the tent doesn't collapse at all or very slowly (> 5 sec), assume that the animal is seriously dehydrated (≥ 8% loss).

The correct assessment of fluid loss with its concomitant electrolyte imbalance is usually beyond the capabilities of field biologists to precisely determine. Depending on the type of fluid loss, the animal's blood pH can be altered, electrolytes (e.g., sodium) lost, and the blood can be hypo- or hypertonic. Each of these conditions actually require a specific course of fluid therapy with over a dozen fluid types from which to choose. It is unlikely that you will be able to determine the osmolar deficit, special ion involvement, or acid-base status and equally unlikely that you will be lugging around several liters of the differing fluids. Thus, it seems most practical for field immobilizations to be equipped with one type of fluid (I prefer lactated Ringer's) in an amount sufficient to treat the target animal.

Veterinary First Aid Kit Checklist

General:

- 16-gauge, 1-inch needles
- 18-gauge, 1.5-inch and 3-inch needles (for intracardiac injections)
- 20/21 gauge, 1-inch needles
- 1-, 3-, 5/6-, 10/12-, and 30/60-ml syringes
- Stomach Tube
- K-Y Jelly
- Endotracheal Tubes - French sizes 28, 36, 44
- IV Drip Set
- Physiological Saline (0.9% NaCl)
- Lactated Ringer's Solution
- Tourniquet (for raising veins)
- Thermometer (electronic or mercury)
- Stethoscope
- Resuscitation Bag

For Wound Management:

- Povidone-iodine or 2% chlorhexidine scrub solution
- Antibiotics (procaine-benzathine penicillin)
- Gauze sponges, 4 cm x 4 cm
- Iodine Surgical Scrubs
- Hemostats
- Tissue forceps
- Spools of sizes 0 and 000 chromic gut (or other absorbable suture)
- Tapered (for muscle) and cutting (for skin) suture needles
- Scalpel Blades
- Scissors
- Roll gauze
- Adhesive tape
- Sterile Surgical or Examination Gloves

Emergency Drugs (be sure drugs are not outdated):

- Naloxone (naltrexone, nalmefene)
- Diazepam or midazolam, 5 mg/ml
- Epinephrine, 0.1 mg/ml (1:10,000)
- Atropine Sulfate, 0.5 mg/ml
- Doxapram hydrochloride, 20 mg/ml
- Dexamethasone, 2 mg/ml
- Calcium Chloride, 10% (100 mg/ml)
- Sodium Bicarbonate, 1 mEq/ml

Emergency Treatment - Human

Quick Reference Guide for Human Exposure to:

Continued next page...

Preventative Measures

There are many agents used in animal immobilization that are potentially lethal to humans. Accidental exposure can occur many ways, but most commonly drugs are sprayed in the eyes or mouth or injected via a syringe with an unprotected needle. Accidental injection by being hit with a dart or receiving the full dose by some other method is rare. However, there has been at least one published fatality and several accidental exposures reported (Firn, 1973; Summerhays, 1976; Allsup, 1977; Goodrich, 1977; Orr, 1977; Carruthers et al., 1979; Haigh and Haigh, 1980;

Parker and Haigh, 1982; Poklis et al., 1985; Petrini and Keyler, 1993). Thus, this discussion is not trivial. Following are some precautionary steps to take and rules to follow that should decrease the chances of accidental drug exposure:

Obtain competent training.

Safe drug handling and use should not be a self-taught course. Attend courses taught by experienced instructors on the use of immobilizing drugs. Unfortunately, there are several "wannabe" individuals teaching chemical immobilization of wildlife, but many of them are woefully inexperienced and misinformed. Make an effort seek out qualified instructors.

Be trained in basic first aid and CPR techniques.

Ideally, everyone involved in the immobilization effort should have this training. Murphy's law would dictate that if only one person on the team had such training, that would be the person who needed medical help!

Always work in pairs.

This is absolutely essential when working with drugs that are potentially lethal.

Always have appropriate antagonists immediately available.

You may not have a second chance to remember the antagonist back in the truck or office. Also have a first aid kit on hand (see "Human First Aid Kit" later).

Wear protective gloves and eye protectors.

Drugs can be spilled, sprayed, dripped, dropped, slopped, and leaked in more ways than you can imagine. Don't spray drugs into the air and don't hold loaded syringes in your mouth (don't laugh - people do it). Also don't smoke, eat, drink, rub your eyes or mouth, or work with open sores when working with immobilizing drugs.

Carefully withdraw drugs from vials.

Do not inject excessive air into drug vials; equalize air pressure in vials with a needle before withdrawing drug. This is particularly important if you work at different altitudes with the same drug vial. Only if needed, tap the syringe to clear air bubbles. Use a small-gauge needle (e.g., 21, 22, or 25 gauge) to withdraw the drug because large-gauge needles will create holes where drug can leak out.

Avoid using pressurized darts when using potent drugs.

Darts whose contents are under pressure by air, butane, or spring tension have their needles capped with a silicone plug or sleeve. When these darts are pressurized, there is a possibility that drug will leak from the sleeve or even discharge prematurely. If you must use pressurized darts, place the needle into a test tube or other device that will contain the drug should it leak.

Treat syringes and darts as if they were guns.

That is, always consider them "loaded" and watch where you point them. Don't carry loaded, unprotected syringes in your pocket; hold them in your hand with protective cap on or carry them in a protective case such as a test tube or cigar case.

Know what you are using.

Make sure the contents of bottles, tubes, and loaded syringes are marked. If you don't know what a drug is, don't use it!

If possible, notify the local emergency care center in advance of your activities.

Most physicians are ignorant of the drugs used in wildlife immobilization and they are unfamiliar with their potency, symptoms, and antagonists. A little communication with the local hospital could save valuable time in an emergency. Either provide the staff, or have on hand, the package inserts of the drugs that you will be using; this information can help the attending physician develop an appropriate treatment. There was a case where a biologist had injected himself and was refused treatment because of the hospital staff's unfamiliarity with the drug.

Be careful with used darts, syringes, and needles.

All of these items will have residual drug remaining on them and many exposures have occurred as a result of careless handling. Store and dispose used needles and syringes with care. It is better not to recap the needle with the cover, rather just discard the needle into an appropriate used-needle disposal container. It is very easy to jab a finger when recapping needles – particularly when you are in a hurry or distracted. Always clean used darts with care. Cap-Chur® darts often have residual pressure remaining in them after they have been fired. With these darts, it is safer to unscrew the tailpiece first to relieve pressure. Even then, have the dart opening pointed away from you. You can also submerge the whole dart under water before disassembling. Wear gloves and goggles when cleaning darts containing potent drugs.

Rules for Accidental Exposure

The previous discussion was concerned with *preventative* measures. Below are rules to follow when there has been an actual accidental exposure. Following this section are specific treatments for the types of drugs commonly used in wildlife immobilization.

Don't panic.

Stay calm and try to determine how much drug could have been delivered. Many "exposures" are needle pricks or slight skin exposure. If there is doubt that a

significant amount of drug has been absorbed, you may wish to quietly wait to determine if any signs of exposure develop. If there are no signs within 15 minutes, you can probably assume that the amount was clinically insignificant. On the other hand, if you know that the person has received a significant drug exposure, you want to work fast, but always under control. You probably have a minimum of three minutes after complete respiratory arrest before there is irreversible brain damage. Considering the amount of time required to absorb drugs after an IM injection, you most likely have much longer than three minutes in which to get your act together. Panic can obfuscate your thinking processes which costs time. Panic by the exposed person may also cause symptoms, such as lightheadedness, fainting, hyperventilation, etc., which can be misinterpreted as a drug effect.

Tell others of the accident.

It is not the time to be embarrassed or feel stupid after you have accidentally injected yourself, particularly with any of the potentially-lethal drugs. Tell someone about the accident immediately!

Wash the site.

Irrigating the injection/exposure site (particularly mucous membranes) with large volumes of water will greatly reduce further drug absorption. An icepack applied to the site may also delay absorption.

Administer the appropriate antagonist(s).

This applies primarily to opioid exposure, but it also includes exposure to the potent alpha-adrenergic agonists such as medetomidine. The administration of opioid antagonists is probably the single most important life-saving action that you can take.

Remember your "ABCs".

A = Airway

Insure that the patient has a clear airway by placing him/her on the back and tilting the head as far back as possible. Be sure the tongue is clear of the pharynx.

B = Breathing

If respiration has ceased, you must begin artificial respiration (mouth-to-mouth) at a rate of one breath every 5 seconds.

C = Circulation

If the heart stops (no pulse, no heart sounds, color bluish), begin cardiac massage by placing the heel of your hand (with the other hand on top of the first) on the lower third of the sternum and push down every sec (i.e., 60 pushes/minute). Continue artificial respiration concurrent with cardiac massage.

Note the time.

Despite the harried circumstances surrounding accidental drug exposure, try to remember when the exposure occurred and when treatments were administered. This time could be valuable in assessing the amount of drug absorbed as well as determining an appropriate treatment regimen.

Transport the person to the nearest emergency center.

If feasible, have the person walk to the vehicle, but not at a strenuous rate. If the person requires CPR or otherwise can't be transported, send for help. If there is no one available to send, *stay with the patient!* Although the exposed person may be conscious when you leave for help, more drug will be absorbed over time and the person may lapse into a coma leading to respiratory depression and death. The major cause of death in cases of accidental exposure is respiratory arrest, but you can artificially resuscitate a person for a long time while waiting for help to arrive. So, don't abandon an exposed person even if that person insists that he/she is all right.

Specific Emergency Treatments

Opioids

Fentanyl, Sufentanil, Carfentanil, Etorphine, A-3080

Symptoms:

- Dizziness, incoordination, lethargy, sedation
- Nausea, vomiting
- Pinpoint pupils
- Breathing slow, shallow, or absent; bluish tinge to skin and mucous membranes; respiratory arrest
- Cold, clammy skin; weak pulse
- Collapse, unconsciousness, and coma
- Cardiovascular collapse (secondary to hypoxia)
- Death

Treatment:

1. Call for help.

Appoint someone to call for help, if available. Otherwise stay with the patient until a third party arrives to help.

2. Wash site.

Flush mucous membranes (eyes, mouth, wound, etc.) with copious amounts of water. Use cool or room temperature water - do not use hot water. If drug was injected IM, keep the wound open and try to express blood from the site.

3. Attempt to establish an IV line.

Try to place a butterfly catheter in a vein and secure with adhesive tape. Use a tourniquet, if needed to raise the vein, then remove it. The veins on the back of the hand are often easier for the inexperienced to hit; otherwise try for the vein on the inside of the elbow.

4. Administer *at least* 30 mg naloxone, naltrexone, or nalmefene *IV.*

Do this only if the patient is demonstrating any of the above symptoms. If the patient is asymptomatic, wait and observe the patient closely; if no symptoms develop within 15 minutes of exposure, no further treatment may be necessary. However, the patient should not be left alone for several hours even in the absence of symptoms. If there is no improvement in the patient's condition within 1 minute after giving the antagonist IV, repeat the dose. Continue to repeat this dose every 3-5 minutes until central nervous system depression is antagonized.

If you can't locate a vein within 60 seconds, administer the antagonist IM. Inject

the antagonist into the large thigh muscles, shoulder, or other available muscle mass. Split the dose and inject into two sites. *Note:* do *not* use diprenorphine (M50-50®) as an antidote in humans due to its side effects.

5. Place victim on side.

Prevent vomiting and aspiration of the vomitus by keeping the individual on his/her side, if unconscious. If the person is conscious, keep him/her moving (walking), if possible.

6. Remember your ABC's and be prepared to apply CPR.

7. Transfer the patient to an emergency center when feasible.

Comments:

You should never use opioids without one of the above three antagonists available. Do not use diprenorphine (M50-50®). Naloxone, naltrexone, and nalmefene are preferred antagonists because they are "pure" antagonists, whereas diprenorphine has both antagonistic and agonistic (undesirable in case of opioid overdose) properties. There are no data on the correct dose of the above three antagonists to administer in cases of human exposure to etorphine and carfentanil. Naloxone, naltrexone, and nalmefene are all very safe drugs and humans should be able to receive amounts much higher than the dose given. If you do not see any effect after IV administration and the person is comatose and/or has stopped breathing, consider increasing the dose.

Cyclohexanes

Ketamine, Tiletamine [in Telazol®], Phencyclidine

Symptoms:

- Disorientation, hallucination, excitement, abnormal behavior
- Coma
- Decreased respiratory rate

Treatment:

1. Wash site.

Flush mucous membranes (eyes, mouth, wound, etc.) with copious amounts of water. Use cool or room temperature water - do not use hot water. If drug was injected IM, keep the wound open and try to express blood from the site.

2. Keep patient quiet.

Minimize stimulation (sound, touch, light, etc.); never leave the patient unattended. Physically restrain the patient, if needed, to prevent self-inflicted injury.

3. Give artificial resuscitation, if necessary.
Respiratory depression is usually seen only when the patient has received a large dose.

4. Administer 10 mg of diazepam if patient has convulsions.
You can administer 10 mg of diazepam (Valium®) or midazolam (Versed®) IV or IM. If given IV, administer *slowly* (10-15 seconds).

5. Transport to emergency center.

Comments:
Remember that the commonly-used cyclohexanes (ketamine, tiletamine) are congeners of phencyclidine, also known as PCP or Angel Dust. We are probably all familiar with accounts of bizarre human behavior resulting from PCP abuse and the most likely result of cyclohexane injection is such abnormal behavior. It is unlikely that the doses of ketamine used in animal immobilization would be lethal to humans since the clinical IM dose for humans can be as high as 13 mg/kg. Despite some common misconceptions, there is no complete antagonist for these cyclohexanes and drugs such as yohimbine, 4-aminopyridine, and atipamezole should not be given.

Neuromuscular Blocking Agents

Succinylcholine, Decamethonium

Symptoms:
- Nausea
- Progressive muscle paralysis
- Decreased respiratory rate, arrest
- Cyanosis
- Unconsciousness
- Death

Treatment:
1. Wash site.
Flush mucous membranes (eyes, mouth, wound, etc.) with copious amounts of water. Use cool or room temperature water - do not use hot water. If drug was injected IM, keep the wound open and try to express blood from the site.

2. Give artificial resuscitation.
If the muscles of respiration become paralyzed, you will have to provide resuscitation until the drug effects wear off.

3. Transport to emergency center.

Comments:
Fortunately, this drug is metabolized quickly (10–20 minutes) and simple maintenance of artificial resuscitation should be sufficient to allow recovery. Recovery of paralysis will be the reverse of induction, i.e., diaphragmatic and intercostal muscles first (therefore, breathing restored) and facial muscles last.

Gallamine, Tubocurarine

Symptoms:
- Nausea
- Progressive muscle paralysis
- Decreased respiratory rate, arrest
- Cyanosis
- Unconsciousness
- Death

Treatment:
1. Wash site.

Flush mucous membranes (eyes, mouth, wound, etc.) with copious amounts of water. Use cool or room temperature water - do not use hot water. If drug was injected IM, keep the wound open and try to express blood from the site.

2. Administer antagonist.

Do *not* give neostigmine as the antagonist *unless* you also have atropine available. The protocol for gallamine antagonism is as follows (Morkel, 1993):

a. Give 0.5 mg atropine IV *slowly* (15–30 seconds) or give IM. If given IM, wait 5 minutes before the next step.
b. Give 1 mg neostigmine IV *slowly* (15–30 seconds) or give IM.
c. Repeat steps 1 and 2 every 5 minutes until recovery, but *not to exceed* three repetitions (i.e., total atropine given is 1.5 mg and total neostigmine given is 3 mg).

3. Give artificial resuscitation.

If you don't have atropine and neostigmine and if the muscles of respiration become paralyzed, you will have to provide resuscitation until the drug effects wear off.

4. Transport to emergency center.

Comments:
Overdosing with neostigmine can be dangerous to the patient, therefore do not exceed recommended dose. Signs of neostigmine overdose include: tremors, violent stomach cramps, defecation/urination/salivation/ difficult breathing, constricted pupils, very slow pulse. If you suspect neostigmine overdose, the protocol for treatment is as follows (Morkel, 1993):

- Give artificial resuscitation, if necessary.
- Give 1 mg atropine IV *slowly*
- If pulse drops below 60 bpm, give 0.5 mg additional atropine. Continue giving increments of 0.5 mg atropine until pulse exceeds 60 bpm, but *do not exceed* 2 mg atropine total dose.

Nicotine Sulfate

Symptoms:

- Nausea, abdominal pain, vomiting, salivation, dizziness
- Headache, disturbed hearing and vision, mental confusion
- Weakness, fainting, collapse
- Difficult breathing, weak and rapid pulse, convulsions, and death due to respiratory failure

1. Give artificial resuscitation.

If the muscles of respiration become paralyzed, you will have to provide resuscitation until the drug effects wear off.

2. Transport to emergency center *immediately*.

Comments:
The lethal dose for humans is 60 mg of nicotine which is within the range of doses used in wildlife immobilization. There is no antidote for nicotine. If you take a lethal dose of nicotine, you will double over with agonizing cramps, vomit, defecate, and then die and there will be nothing anyone can do for you. Take home message: *never* use nicotine sulfate!

Tranquilizers/Sedatives

Xylazine, Detomidine, Medetomidine

SYMPTOMS:

- Decreased respiratory and heart rate
- Sedation, dizziness, nausea
- Hypothermia

Treatment:

1. Support respiration, if necessary.

Administer artificial resuscitation if patient's respiratory rate falls below 6 breaths per minute or if lips and gums become pale or bluish.

2. Give 0.5 mg atropine IV *slowly* (10–15 seconds) for decreased heart rate.

Give atropine if the heart rate falls below 40 bpm. This dose may repeated in five minutes until the heart rate increases; do not exceed 1.5 mg total dose of atropine.

3. Give 2 mg naloxone IV.

Although naloxone is not an antagonist for xylazine, it has been given to humans to counteract the hyoptension and bradycardia associated with an overdose of this class of drugs.

Comments:

The above suggested treatment is for clonidine overdose, a drug used in humans that has similar actions to xylazine. In one reported case of overdose with xylazine, a person injected 1,000 mg (1 gm) xylazine IM in a suicide attempt (Carruthers et al., 1979). This resulted in coma and depressed respiration with recovery after about 60 hours of intensive care. A fatality involving a xylazine overdose coupled with alcohol and clorazepate ingestion has also been reported (Poklis et al., 1985).

The alpha-adrenergic antagonists, such as tolazoline, yohimbine and atipamezole, are currently *not* recommended as an antagonist in humans. However, tolazoline at a dose 10 mg IV has been given when other treatments have failed and treatment is deemed necessary. This dose can be repeated every 5–10 minutes as needed up to a maximum of 40 mg. Again, the most likely problem with xylazine/detomidine/medetomidine exposure is that they will be in conjunction with primary immobilizing agents and can potentiate such adverse effects as respiratory depression.

Diazepam, Midazolam

Symptoms:

- Decreased respiratory rate
- Ataxia, lethargy, slurred speech
- Sleepiness, coma

Treatment:

1. Support respiration, if necessary.

Administer artificial resuscitation if patient's respiratory rate falls below 6 breaths per minute or if lips and gums become pale or bluish.

2. Administer flumazenil at 0.2 mg IV followed by 0.1 mg IV every minute until patient responds.

Flumazenil is a benzodiazepine antagonist that has been used in cases of severe benzodiazepine overdose; it has a high therapeutic index (3,000) so overdosing with this antagonist is unlikely.

3. Transport to emergency center.

Comments:
Death due to overdose of benzodiazepine tranquilizers is rare and highly unlikely given the doses of these drugs used in wildlife immobilization. In one case, oral ingestion of 1,500 mg diazepam caused only minor toxicity. Exposure to these agents would most likely be in conjunction with, and therefore exacerbate the effects of, primary immobilizing agents (opioids, cyclohexanes).

Promazine, Chlorpromazine, Propionylpromazine, Acetylpromazine, Haloperidol, Azaperone, Droperidol, Perphenazine

Symptoms:
- CNS stimulation (tremors, rhythmic movements, constant movement, facial grimacing, stiff neck and/or tongue)
- Tachycardia (rapid heart rate)
- Seizures
- Hyper- or hypothermia
- Ataxia, lethargy, slurred speech, akinesia (affective indifference)

Treatment:
1. Support respiration and cardiovascular function, if necessary.
Administer artificial resuscitation if patient's respiratory rate falls below 6 breaths per minute or if lips and gums become pale or bluish. In rare cases, ventricular fibrillation may occur requiring full CPR and immediate transport to an emergency treatment center.

2. Administer 10 mg diazepam IV *slowly* (10-15 seconds) for seizures.
This dose may be repeated every 10–15 minutes as needed to control seizures; do not exceed 30 mg total dose of diazepam.

3. Transport to emergency center.

Comments:
Death due to overdose of phenothiazine and butyrophenone tranquilizers is rare and highly unlikely given the doses of these drugs used in wildlife immobilization. Exposure to these agents would most likely be in conjunction with, and therefore exacerbate the effects of, primary immobilizing agents (opioids, cyclohexanes).

In very unusual cases, a neuroleptic malignant syndrome may appear after several hours to months, most often after haloperidol overdose. This syndrome is characterized by profound hyperthermia, tachycardia, hypotension or hypertension, and fluctuating mental status progressing to coma.

Human First Aid Kit Checklist

General:

- 20 or 21 ga. needles
- 1-ml syringes
- 3-ml syringes
- 10-ml syringes
- 23-ga IV Butterfly Cannulas
- Adhesive Tape
- IV Drip Set
- Physiological Saline (0.9% NaCl)
- Tourniquet (for raising vein)
- Thermometer
- Stethoscope
- Gauze, 2-in.
- Scissors
- Band-aids
- Topical Antibiotic
- Iodine Surgical Scrubs
- Forceps (tweezers)
- Scalpel Blades
- 3-0 Absorbable Sutures with Cutting Needle
- Hemostats
- Sterile Surgical or Examination Gloves

Emergency Drugs (be sure drugs are not outdated):

- Naloxone (naltrexone, nalmefene)
- Diazepam or midazolam, 5 mg/ml
- Epinephrine, 0.1 mg/ml (1:10,000)
- Atropine Sulfate, 0.5 mg/ml
- Neostigmine Methylsulfate, 1 mg/ml
- Methylprednisolone Sodium Succinate

Chapter 6

Drug Doses

This chapter lists species by common name in alphabetical order. Scientific names are also provided should there be confusion about the common name. Scientific names were taken from *Walker's Mammals of the World* (Nowak, 1991). The information provided is intentionally designed to be brief to enable the user to quickly locate a specific animal and to simplify the decision-making process. The following information is provided for each animal, as applicable:

Weight: The average *adult* weight, or range of weights, is listed. Weights were derived either from the literature, the personal records of the author or others, or from *Walker's Mammals of the World* (Nowak, 1991). All weights are in metric units; if you need to convert pounds to kilograms, refer to the conversion chart in the back of this manual.

Recommended Drug: This is an appropriate drug and dose for the species under most circumstances. Unless otherwise stated, it is assumed that these drugs will be administered *intramuscularly*.

Note: Be sure to read all doses carefully. I have tried to maintain consistency by using doses based on mg drug per kg body weight (mg/kg). Some drugs, however, are formulated as mixtures, thus doses are given as *ml* of drug per kg body weight. Some doses are also given as *total body dose* and are based on average, adult body weights.

Also note the intentional inconsistency of doses relative to style. Where doses are fractionated (e.g., 0.125 mg/kg, 1.5 mg/kg), I have used appropriate style. However, when doses are in whole numbers (e.g., 5 mg/kg, 10 mg/kg), I have omitted the decimal point and the following zero (e.g., 5.0 mg/kg). The reason for this is that I did not want someone, who in haste or in poor light, to miss the decimal point and give the animal *10 times* the recommended dose.

I have tried to use chemical names (e.g., ketamine) as opposed to trade names (e.g., Ketaset®) wherever possible. However, for simplicity, to save space, and to avoid confusion, I have used trade names for drugs which are a combination of two agents (e.g., Telazol®, Immobilon®). Where there is more than one trade name for these combination drugs (e.g., Telazol®, Zoletil®), I have used only one of the names throughout (e.g., Telazol®). If you are unfamiliar with the trade name, refer to *Chapter 1, Capture Drugs* for an explanation of the contents.

Supplemental Drug: Use this drug and dose should the original dose not immobilize the animal, or if there was only partial injection.

Antagonist: If the recommended drug can be antagonized, the appropriate drugs and doses will be listed here. Antagonists are given *intravenously,* unless otherwise stated. For most opioid immobilizations, antagonist doses are given as mg of antagonist per mg of opioid given. For example, the antagonist dose for carfentanil is 100 mg naltrexone or naloxone per mg carfentanil given. Thus, if you gave an initial dose of 5 mg carfentanil, then gave a booster dose of 2.5 mg carfentanil, the total dose of naltrexone or naloxone required would be 750 mg ([5 mg + 2.5 mg carfentanil] x 100 mg naltrexone/mg carfentanil).

Alternative Drugs: These are drugs and doses which also have successfully immobilized the species. Their listing as "alternative" in no way implies that they are less effective than the recommended drug. If you are more familiar with one of these alternative drugs, then by all means use it.

Comments: Additional information, particularly cautions, will be provided here.

References: References applicable to the species are provided for your information and further reading. I strongly recommend obtaining and reading these references prior to immobilizing the animal. Much information is contained therein that is not presented in the *Comments* portion for each species, yet will be of use and interest to you. Some references may not contain information specifically on chemical immobilization, but they have been included for general information or historical purposes.

In general, the references that I have included in the bibliography are studies involving several animals. I intentionally omitted a large body of literature where only a single animal was immobilized for some specific purpose such as examination or surgery. Sample sizes of $n = 1$ rarely have value. I have spent a great deal of effort to amass what I believe is the most comprehensive bibliography of chemical immobilization in the world. However after making that boast, I will also readily admit that I didn't find all applicable references, particularly those published outside of North America. If you feel that I have forgotten a significant reference, please feel free to notify me and I will include it in subsequent editions.

Can't Find Your Critter?

Although this chapter provides drug doses for more than 450 species, there might not be information available for your particular animal of concern. In such cases, you could look up a closely-related species and use the provided doses as a starting point. For example, there isn't a dose listed for yellow-bellied marmot, *Marmota flaviventris*, but there is a dose for woodchuck, *Marmota monax*.

If all else fails, you could estimate an initial dose of ketamine and xylazine by using the below graph (Figure 11). This graph is a composite of ketamine/xylazine doses for 44 mammalian species, ranging from rodents to elephants. The data were plotted and formulae for the best-fitted curve created. To use this graph, start with the body weight (known or estimated) and draw a straight line upwards until it intersects both the ketamine and the xylazine lines. Then draw a line to both Y axes to determine the ketamine and xylazine doses. Note that *all* axes are logarithmic; doses will only be estimates due the nature of such scales. Also remember that the derived doses will be mg of drug per kg body weight and *not* the *total* dose. The derived doses should serve as starting doses only; be prepared to adjust upwards or downwards based on your initial results.

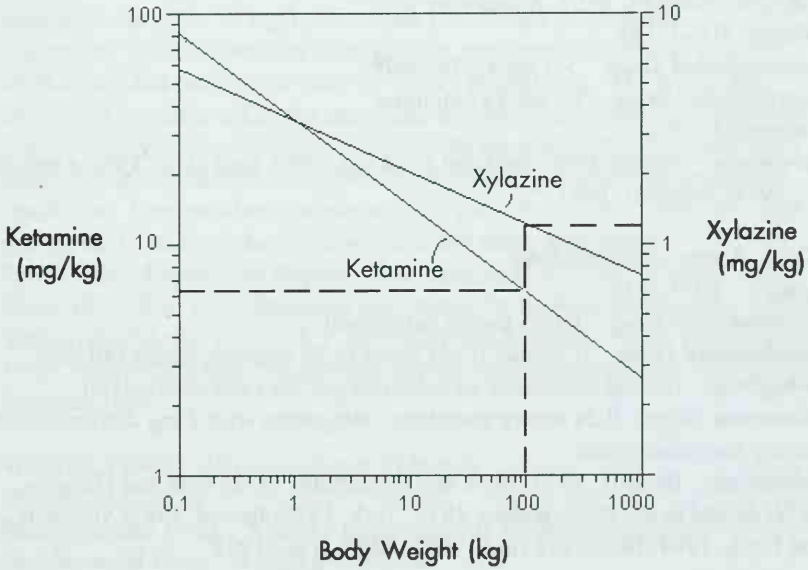

Figure 11. Ketamine-xylazine doses derived from 44 mammalian species. Formulae for best-fitted curves were: ketamine (mg/kg) = $34.387BW^{-0.369}$ and xylazine (mg/kg) = $3.454BW^{-0.223}$. Dotted lines denote an example of a 100-kg animal resulting in an initial ketamine dose of approximately 6.3 mg/kg and a xylazine dose of approximately 1.2 mg/kg. Note that all axes are logarithmic.

Drug Doses by Species

AARDVARK, *Orycteropus afer*
Weight: 50–70 kg
Recommended Drug: 15 mg/kg ketamine
Supplemental Drug: 7 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; 1976; Jessup et al., 1980; IWVS, 1992

AARDWOLF, *Proteles cristatus*
Weight: 9–14 kg
Recommended Drug: 15 mg/kg ketamine plus 0.3 mg/kg acepromazine
Supplemental Drug: 8 mg/kg ketamine
Antagonist: None
Comments: Use lightweight darts with a low-impact darting system.
References: Young, 1966; Seal et al., 1970; Anderson and Richardson, 1992; IWVS, 1992; Richardson and Anderson, 1993

ACOUCHIS (GREEN, RED), *Myoprocta spp.*
Weight: 0.6–1.3 kg
Recommended Drug: 5.5 mg/kg Telazol®
Supplemental Drug: 5.5 mg/kg ketamine
Antagonist: None
References: Young, 1966; Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Schobert, 1987

ADDAX, *Addax nasomaculatus*
Weight: 60–125 kg
Recommended Drug: 0.025 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 0.24 mg/kg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
References: Bauditz, 1972; Heck and Rivenburg, 1972; York and Huggins, 1972; Alford et al., 1974; Röken, 1975; York, 1975; Jensen, 1982; Silvestris and Heck, 1984; Densmore et al., 1987; Allen et al., 1991

AGOUTI, *Dasyprocta spp.*
Weight: 1.3–4 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 60 mg/kg ketamine

References: Seal and Erickson, 1969; Seal et al., 1970; Bacher et al., 1976; Genevois et al., 1984a

ALLIGATOR - SEE CROCODILIANS

ALPACA, *Lama pacos*
Weight: 55–65 kg
Recommended Drug: 1 mg/kg ketamine plus 0.05 mg/kg medetomidine
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 0.25 mg/kg atipamezole
Alternative Drugs: 2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine • 4 mg/kg Telazol®
Comments: Jones (1977a) stated that the use of opioids in llama was contraindicated; assume the same for alpaca.
References: Rapley and Mehren, 1975

AMPHIBIANS, GENERAL
Recommended Drug: 2-10 mg/10 ml water (0.02-0.1%) tricaine methane sulfonate at pH 7.0
Antagonist: Wash amphibian repeatedly in clean, warm water (no anesthetic)
Alternative Drugs: 50 mg/kg ketamine plus 1 mg/kg diazepam
Comments: Use higher dose rates tricaine methane sulfonate for *smaller* amphibians and lower dose rates for *larger* amphibians. The longer the amphibian is immersed in the anesthetic solution, the longer the duration of effect. Always induce immobilization with the lowest effective dose possible. Adult amphibians can drown if left submerged while under general anesthesia. Gas anesthesia works well for amphibians also. Telazol® does not appear to be a satisfactory anesthetic for many amphibians.
References: Kaplan and Kaplan, 1961; Kaplan et al., 1962; Kaplan, 1969; Beck, 1972; Rie, 1973; Stunkard and Miller, 1974; Wass and Kaplan, 1974; Vethamany-Globus et al., 1977; Robinson and Scadding, 1983; Cooper, 1984; 1987; Sedgwick, 1986; Letcher and Amsel, 1989; Letcher, 1992; Letcher and Durante, 1995

ANTEATER, GIANT, *Myrmecophaga tridactyla*
Weight: 18–39 kg
Recommended Drug: 5 mg/kg ketamine plus 3.5 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 11 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Beck, 1976; Gillepsie and Adams, 1985; Kock et al., 1989

ANTEATER, LESSER (TAMANDUA), *Tamandua tetradactyla*
Weight: 2–7 kg

Recommended Drug: 15 mg/kg Telazol®
Supplemental Drug: 15 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970

ANTELOPE, NORTH AMERICAN - SEE PRONGHORN

ANTELOPE, FOUR-HORNED, *Tetracerus quadricornis*
Weight: 17–21 kg
Recommended Drug: 15 mg/kg ketamine
Supplemental Drug: 8 mg/kg ketamine
Antagonist: None
References: Shashidhar, 1981

ANTELOPE, ROAN, *Hippotragus equinus*
Weight: 100–325 kg
Recommended Drug: 0.025 mgkg etorphine plus 0.25 mg/kg xylazine
Supplemental Drug: 0.015 mg/kg etorphine
Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Alternative Drugs: 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
• 60 mg fentanyl plus 200 mg azaperone; antagonize with 0.2 mg/kg naloxone
• 3 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine (calm animals only)
Comments: Aggressive to each other when captured in groups; immediately immobilize if captured in bomas. If confined in bomas, the etorphine dose can be reduced. Approach downed animals carefully; semi-immobilized animals can rake with their horns.
References: Lanphear, 1963; Pienaar, 1968a; 1968b; 1973a; Koci, 1971b; 1972; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; Hofmeyr and de Bruine, 1973; Hofmeyr, 1974; De Vos, 1975; Röken, 1975; Smuts, 1975; Haigh, 1976d; Jones, 1977; Slee and Walker, 1977; De Vos, 1978a; Hofmeyr, 1981; Silvestris and Heck, 1984; Williams and Riedesel, 1987; Kock et al., 1989; IWVS, 1992; Morkel, 1992; Burroughs, 1993d

AOUDAD, *Ammotragis lervia*
Weight: 40–55 (f) 100–145 (m) kg
Recommended Drug: 10 mg/kg ketamine plus 2.5 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 1.5 mg/kg ketamine plus 0.12 mg/kg medetomidine; antagonize with 0.6 mg/kg atipamezole

- 0.005 mg/kg carfentanil plus 0.1 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
- 3 mg etorphine plus 10 mg ketamine plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
- 1.5 mg/kg xylazine; antagonize 0.2 mg/kg yohimbine (calm animals only)
- 6 mg/kg Telazol®

Comments: The use of xylazine without an antagonist may cause extremely prolonged recoveries (Klöppel, 1969; Gauckler and Kraus, 1970). When using ketamine-medetomidine, wait 5 minutes after recumbency before approaching animal.

References: Jarvis and Morris, 1960; Thomas, 1961; Heuschele, 1961a; Wright, 1963; Wallach et al., 1967; Wallach, 1968; 1969; Klöppel, 1969; Gauckler and Kraus, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; York and Huggins, 1972; Woolf et al., 1973; Boever and Paluch, 1974; Mehren and Rapley, 1975; Rapley and Mehren, 1975; Röken, 1975; York, 1975; Wiesner, 1977; Jessup, et al., 1980; Wiesner et al., 1982; 1984; Jacobson and Kollias, 1984; Silvestris and Heck, 1984; Schobert, 1987; Williams and Riedesel, 1987; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Snyder et al., 1992

APE, BARBARY, *Macaca sylvanus*

Weight: 6–15 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine
References: Bauditz, 1972; Gray et al., 1974; Bush et al., 1977; Schobert, 1987

APE, CELEBES, *Cynopithecus niger*

Weight: 6–15 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 25 mg/kg ketamine
References: Gray et al., 1974; Beck, 1976; Bush et al., 1977; Schobert, 1987

ARMADILLO, *Dasypus novemcinctus*

Weight: 3–10 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None

ASS, WILD, *Equus asinus*

Weight: 200–250 kg
Recommended Drug: 3 mg etorphine plus 200 mg xylazine

Supplemental Drug: 1.5 mg etorphine
Antagonist: 2 mg diprenorphine per mg etorphine given
Alternative Drugs: 1.5 ml Large Animal Immobilon® plus 50 mg xylazine; antagonize with 7.5 mg diprenorphine
• 1 mg etorphine plus 300 mg ketamine plus 300 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
References: Heuschele, 1961; Heck and Rivenburg, 1972; Röken, 1975; Jessup et al., 1980; Wiesner et al., 1982; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985

BABOON, CHACMA, *Papio ursinus*
Weight: 8–30 kg
Recommended Drug: 3 mg/kg Telazol®
Supplemental Drug: 3 mg/kg ketamine
Antagonist: None
Alternative Drugs: 12 mg/kg ketamine
References: Kroll, 1962; Van Niekerk et al., 1963a; Van Niekerk and Pienaar, 1963a; Field et al., 1966; Steyn, 1975; Beck, 1976; Melton, 1980; Goosen et al., 1984; Van Der Merwe et al., 1987; Jessup et al., 1980; Melton and Melton, 1982; Schobert, 1987; Burroughs, 1993c

BABOON, GELADA, *Theropithecus gelada*
Weight: 13–20 kg
Recommended Drug: 2.5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 11 mg/kg ketamine
References: Kroll, 1962; Field et al., 1966; Gray et al., 1974; Beck, 1976; Eads, 1976; Bush et al., 1977; Schobert, 1987

BABOON, HAMADRYAS, *Papio hamadryas*
Weight: 10–18 kg
Recommended Drug: 5 mg/kg ketamine plus 0.1 mg/kg medetomidine
Supplemental Drug: 3 mg/kg ketamine
Antagonist: 0.5 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 12 mg/kg ketamine
• 1.3 mg/kg Telazol®
Comments: Ketamine-medetomidine use may not induce complete immobilization; increase amount of ketamine, if necessary.
References: Kroll, 1962; Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; 1976; Schobert, 1987; Jalanka and Roeken, 1990

BABOON, OLIVE, *Papio anubis*
Weight: 14–41 kg
Recommended Drug: 10 mg/kg ketamine plus 0.25 mg/kg diazepam

Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 4.4 mg/kg Telazol®
• 15 mg/kg ketamine
References: Kroll, 1962; Ericksen, 1968; Field et al., 1966; Bauditz, 1972; Beck, 1972; Beck and Dresner, 1972; Jessup et al., 1980; Woolfson et al., 1980; Schobert, 1987

BABOON, WESTERN, *Papio papio*
Weight: 10–30 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 5 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Heuschele, 1959; 1961a; 1961b; Kroll, 1962; Vondruska, 1965; Beck, 1976; Cohen and Bree, 1978

BABOON, YELLOW, *Papio cynocephalus*
Weight: 14–41 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine plus 0.5 mg/kg xylazine
References: Beck and Dresner, 1972; Eads, 1976; White and Cummings, 1976; Schobert, 1987; Burroughs, 1993c

BADGER, EUROPEAN (OLD WORLD), *Meles meles*
Weight: 10–16 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 0.4 mg/kg acepromazine
• 16 mg/kg ketamine plus 6 mg/kg xylazine
References: Seal and Erickson, 1969; Seal et al., 1970; Hunt, 1976; Mackintosh et al., 1976; Wiesner and von Hegel, 1985; Wolfensohn, 1992; Travaini et al., 1994

BADGER, FERRET, *Melogale moschata*
Weight: 1–3 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970

BADGER, HOG, *Arctonyx collaris*
Weight: 7–14 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 2.2 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970

BADGER, HONEY, *Mellivora capensis*
Weight: 7–13 kg
Recommended Drug: 2.2 mg/kg Telazol®
Supplemental Drug: 2.2 mg/kg ketamine
Antagonist: None
Alternative Drugs: 6 mg/kg ketamine plus 0.5 mg/kg xylazine
Comments: Approach either darted or trapped honey badgers with care.
References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Schobert, 1987; McKenzie and Burroughs, 1993

BADGER, *Taxidea taxus*
Weight: 4–12 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 1 mg/kg xylazine
Comments: Badgers require care in drug administration because they struggle and resist handling; try to physically restrain the animal to insure accurate drug injection.
References: Seal and Erickson, 1969; Seal et al., 1970; Bailey, 1971; Fitzgerald, 1973; Boever et al., 1977; Jessup et al., 1980; Jessup, 1982b; Genevois et al., 1984b; Schobert, 1987; Seal and Kreeger, 1987; Pigozzi, 1988; Pond and O'Gara, 1994

BANDICOOT, LONG-NOSED, *Perameles gunnii*
Weight: 450–900 gm
Recommended Drug: 0.005 mg/gm Telazol®
Supplemental Drug: 0.005 mg/gm ketamine
Antagonist: None
References: Shima et al., 1993

BANDICOOT, SHORT-NOSED, *Isoodon macrourus*
Weight: 1–1.5 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
References: Denny, 1974; Holz, 1992

BANTENG, *Bos javanicus*

Weight: 400–900 kg

Recommended Drug: 2 ml Large Animal Immobilon® plus 50 mg xylazine

Supplemental Drug: 1 ml Large Animal Immobilon®

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 1.5 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

References: Göltenboth and Klös, 1970; Bauditz, 1972; Wiesner et al., 1982

BARASINGHA, *Cervus duvauceli*

Weight: 172–181 kg

Recommended Drug: 2.1 mg carfentanil

Supplemental Drug: If animal is not down in 20 min, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given

Alternative Drugs: 0.015 mg/kg etorphine plus 0.5 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

• 1 mg etorphine plus 100 mg ketamine plus 100 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Comments: Prone to sudden leg kicks when immobilized with carfentanil.

References: Jarvis and Morris, 1960; Thomas, 1961; Heck and Rivenburg, 1972; Jones, 1972; 1984; Woolf et al., 1973; Rapley and Mehren, 1975; Wiesner, 1975; 1977; Jensen, 1982; Wiesner et al., 1982; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Seal and Bush, 1987; Allen et al., 1991

BATS, GENERAL

Recommended Drug: 10 mg/kg ketamine plus 2 mg/kg xylazine

Supplemental Drug: 5 mg/kg ketamine

Antagonist: None reported

Alternative Drugs: 10 mg/kg ketamine plus 1 mg/kg acepromazine

References: Beck, 1976; Rauch and Beatty, 1977; Bassett, 1987; Wilson, 1988; Heard et al., 1996

BEAR, ASIATIC BLACK, *Ursus thibetanus*

Weight: 65–90 (f), 110–150 (m) kg

Recommended Drug: 4.4 mg/kg Telazol®

Supplemental Drug: 2.2 mg/kg ketamine

Antagonist: None

References: Jarvis and Morris, 1960; Heuschele, 1961a; Kuntze, 1967; Seal and Erickson, 1969; Seal et al., 1970; Schobert, 1987

BEAR, BLACK, *Ursus americanus*

Weight: 92–140 (f), 115–270 (m) kg

Recommended Drug: 4.4 mg/kg ketamine plus 2 mg/kg xylazine

Supplemental Drug: 2.2 mg/kg ketamine
Antagonist: 0.15 mg/kg yohimbine
Alternative Drugs: 7 mg/kg Telazol®
• 1.5 mg/kg ketamine plus 0.04 mg/kg medetomidine; antagonize with 0.2 mg/kg atipamezole
• 0.02 mg/kg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
Comments: Respiratory depression may occur with etorphine. Anesthetic induction with Telazol® may take up to 20 min and recoveries may be prolonged; however, combining Telazol® with medetomidine may reduce this.
References: Martyn, 1955; Erickson, 1957; Black et al., 1959; Meyer, 1959; Youatt and Erickson, 1959; Jarvis and Morris, 1960; Heuschele, 1961a; Clifford et al., 1962; Kroll, 1962; Clarke et al., 1963; Dyson, 1965; Kuntze, 1967; Pearson et al., 1968; Wallach et al., 1967; Wallach, 1968; 1969; Seal and Erickson, 1969; Rogers, 1970; Seal et al., 1970; Bauditz, 1972; Miller et al., 1973; Alford et al., 1974; Beeman et al., 1974; Miller and Will, 1974; Haigh, 1976d; Hugie et al., 1976; Miller and Will, 1976; Rogers et al., 1976; Hugie et al., 1977; Addison and Kolenosky, 1979; Barnes and Rogers, 1980; Bush et al., 1980a; Jessup, 1982b; Stewart et al., 1980; Carpenter and Lance, 1983; Lynch et al., 1982; Cook, 1984; Genevois et al., 1984b; Clutton, 1987; Garshelis et al., 1987; Schobert, 1987; Seal and Kreeger, 1987; Hellgren and Vaughn, 1989; Barnett and Lewis, 1990; Gibeau and Paquet, 1991; McLaughlin, 1993; Pond and O'Gara, 1994; Ramsay et al., 1995; White et al., 1996

BEAR, BROWN (GRIZZLY), *Ursus arctos*
Weight: 100–325 kg
Recommended Drug: 8 mg/kg Telazol®
Supplemental Drug: 2 mg/kg ketamine
Antagonist: None
Alternative Drugs: 2 mg/kg Telazol® plus 0.06 mg/kg medetomidine; antagonize with 0.3 mg/kg atipamezole
• 11 mg/kg ketamine plus 11 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
• 0.012 mg/kg carfentanil plus 0.3 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
• 0.02 mg/kg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
Comments: Spontaneous arousals may occur when ketamine-medetomidine is used; avoid loud or sharp noises; try to prevent vocalization of cubs when mother is immobilized. Body weights can vary widely depending on geographical location.
References: Louw, 1957; Craighead et al., 1960; Jarvis and Morris, 1960; Heuschele, 1961a; Troyer et al., 1961; Larsen, 1963; Kuntze, 1967; Ericksen, 1968; Pearson et al., 1968; Wallach, 1968; 1969; Seal and Erickson, 1969;

Seal et al., 1970; Hebert et al., 1970; Bauditz, 1972; Halloran and Pearson, 1972; Pearson and Halloran, 1972; Alford et al., 1974; Gray et al., 1974; Boever et al., 1977; Perry, 1977; Bush et al., 1980a; Hebert et al., 1980; Gatesman and Wiesner, 1982; Lynch et al., 1982; Wiesner et al., 1982; 1984; Carpenter and Lance, 1983; Genevois et al., 1984b; Duchamps, 1985; Wiesner and von Hegel, 1985; Hugues et al., 1986; Röken, 1987; Schobert, 1987; Seal, 1987; Seal and Kreeger, 1987; Carr, 1989; Taylor et al., 1989; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Tsubota and Yamamoto, 1991; Pond and O'Gara, 1994

BEAR, POLAR, *Ursus maritimus*

Weight: 150–300 (f), 300–800 (m) kg

Recommended Drug: 8 mg/kg Telazol®

Supplemental Drug: 2 mg/kg ketamine

Antagonist: None

Alternative Drugs: 0.02 mg/kg carfentanil; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given

- 2.5 mg/kg ketamine plus 0.03 mg/kg medetomidine; antagonize with 0.15 mg/kg atipamezole
- 0.035 mg/kg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
- 7 mg/kg ketamine plus 7 mg/kg xylazine (use 3 mg/kg ketamine plus 3 mg/kg xylazine for cubs of the year)

Comments: Polar bears are subject to hyperthermia and require monitoring. Renarcotization with carfentanil is possible (Scheinsburg and Haigh, 1982), thus it is recommended to give an additional dose of the antagonist SC or IM to prolong absorption. Severe respiratory depression is also possible with carfentanil use. Spontaneous recovery may occur with ketamine-medetomidine; avoid loud or sharp noises; try to prevent vocalization of cubs when mother is immobilized.

References: Heck, 1965; Larsen, 1966; Flyger et al., 1967; Kuntze, 1967; Larsen, 1967; 1971; Lentfer, 1968; Seal and Erickson, 1969; Seal et al., 1970; Treimo, 1970; Kistchinski and Uspenski, 1970; Treimo, 1971; Bauditz, 1972; Robinson and Sedgwick, 1973; Alford et al., 1974; Beck, 1976; Eriksen, 1976; Kuntze, 1976; Boever et al., 1977; Patenaude, 1979; Lee et al., 1981; Gatesman and Wiesner, 1982; Scheinsburg et al., 1982; Taylor et al., 1982; Wiesner et al., 1982; Haigh et al., 1983; 1984; 1985; Ramsay et al., 1985; Stirling et al., 1985; 1989; Wiesner and von Hegel, 1985; Ramsay and Stirling, 1986; Schobert, 1987; Seal and Kreeger, 1987; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Torgerson, 1990; Williams et al., 1990a

BEAR, SLOTH, *Melurus ursinus*

Weight: 55–145 kg

Recommended Drug: 6 mg/kg Telazol®

Supplemental Drug: 2 mg/kg ketamine

Antagonist: None
Alternative Drugs: 7.5 mg/kg ketamine plus 2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
References: Jarvis and Morris, 1960; Heuschele, 1961a; Kuntze, 1967; Seal and Erickson, 1969; Seal et al., 1970; Nair, 1977; Bush et al., 1980a; Page, 1986; Schobert, 1987

BEAR, SPECTACLED, *Tremarctos ornatus*
Weight: 60–140 kg
Recommended Drug: 6 mg/kg Telazol®
Supplemental Drug: 2 mg/kg ketamine
Antagonist: None
References: Jarvis and Morris, 1960; Pistey and Wright, 1961; Graham-Jones, 1964; Kuntze, 1967; Wallach, 1968; 1969; Seal and Erickson, 1969; Seal et al., 1970; Bauditz, 1972; Boever et al., 1977; Nair, 1977; Bush et al., 1980a; Genevois et al., 1984b; Schobert, 1987

BEAR, SUN, *Ursus malayanus*
Weight: 50–73 kg
Recommended Drug: 3 mg/kg ketamine plus 0.07 medetomidine
Supplemental Drug: 2 mg/kg ketamine
Antagonist: 0.35 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 5 mg/kg Telazol®
References: Jarvis and Morris, 1960; Kroll, 1962; Seal and Erickson, 1969; Seal et al., 1970; Pistey and Wright, 1961; Kuntze, 1967; Beck, 1976; Boever et al., 1977; Bush et al., 1980a; Schobert, 1987; Barnett and Lewis, 1990

BEAVER, *Castor canadensis*
Weight: 12–25 kg
Recommended Drug: 10 mg/kg ketamine plus 1 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None reported
Alternative Drugs: 11 mg/kg ketamine plus 0.22 mg/kg acepromazine
• 5 mg/kg Telazol®
References: Allen, 1965; Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; 1976; Lancia et al., 1978; Jessup et al., 1980; Hoilien and Oates, 1982; Jessup, 1982b; Wright, 1983; Seal and Kreeger, 1987

BETTONG, BRUSH-TAILED, *Bettongia penicillata*
Weight: 1.1–1.6 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
References: Holz, 1992

BINTURONG, *Arctictus binturong*
Weight: 9–14 kg
Recommended Drug: 2 mg/kg Telazol®
Supplemental Drug: 2 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Schobert, 1987

BIRDS, GENERAL NONPASSERINE
Weight: < 30 gm
Recommended Drug: 0.035 mg/gm ketamine
Supplemental Drug: 0.02 mg/gm ketamine
Alternative Drugs: 0.02 mg/gm ketamine plus 0.004 mg/gm xylazine

Weight: 30–100 gm
Recommended Drug: 0.025 mg/gm ketamine
Supplemental Drug: 0.015 mg/gm ketamine
Alternative Drugs: 0.015 mg/gm ketamine plus 0.003 mg/gm xylazine

Weight: 100–200 gm
Recommended Drug: 0.02 mg/gm ketamine
Supplemental Drug: 0.01 mg/gm ketamine
Alternative Drugs: 0.01 mg/gm ketamine plus 0.002 mg/gm xylazine

Weight: 200–800 gm
Recommended Drug: 0.015 mg/gm ketamine
Supplemental Drug: 0.008 mg/gm ketamine
Alternative Drugs: 0.01 mg/gm ketamine plus 0.002 mg/gm xylazine

Weight: 0.8–5 kg
Recommended Drug: 10 mg/kg ketamine
Supplemental Drug: 5 mg/kg ketamine
Alternative Drugs: 5 mg/kg ketamine plus 1 mg/kg xylazine

Weight: 5–100 kg
Recommended Drug: 2.5 mg/kg ketamine plus 0.5 mg/kg xylazine
Supplemental Drug: 1.25 mg/kg ketamine
Antagonist: None reported
References: Marsboom et al., 1964; Smith, 1967; Williams and Phillips, 1972; 1973; Cooper and Frank, 1973; Webster and Hollard, 1973; Stunkard and Miller, 1974; Boever and Wright, 1975; Jones, 1977b; Amand, 1980; Smith et al., 1980; Neal et al., 1981; Hartsfield, 1982; Samour et al., 1984; Allen and Oosterhuis, 1986; Freeman, 1986; Linn, 1986; Sedgwick, 1986; Taylor, 1987; Degernes et al., 1988; Avery, 1993b; Hochleithner, 1993

BIRDS, GENERAL PASSERINE

Weight: < 30 gm
Recommended Drug: 0.06 mg/gm ketamine
Supplemental Drug: 0.003 mg/gm ketamine
Alternative Drugs: 0.03 mg/gm ketamine plus 0.006 mg/gm xylazine

Weight: 30–100 gm
Recommended Drug: 0.045 mg/gm ketamine
Supplemental Drug: 0.025 mg/gm ketamine
Alternative Drugs: 0.025 mg/gm ketamine plus 0.005 mg/gm xylazine

Weight: 100–200 gm
Recommended Drug: 0.035 mg/gm ketamine
Supplemental Drug: 0.02 mg/gm ketamine
Alternative Drugs: 0.02 mg/gm ketamine plus 0.004 mg/gm xylazine

Weight: 200–500 gm
Recommended Drug: 0.03 mg/gm ketamine
Supplemental Drug: 0.015 mg/gm ketamine
Alternative Drugs: 0.015 mg/gm ketamine plus 0.003 mg/gm xylazine

Weight: 0.5–1 kg
Recommended Drug: 10 mg/kg ketamine plus 2 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None reported
References: Schafer et al., 1967; Smith, 1967; Peek, 1972; Schafer and Cunningham, 1972; Williams and Phillips, 1972; Stunkard and Miller, 1974; Boever and Wright, 1975; Jones, 1977b; Amand, 1980; Krechetov, 1980; Hartsfield, 1982; Mueller, 1982; Cooper, 1984; Samour et al., 1984; Allen and Oosterhuis, 1986; Linn, 1986; Sedgwick, 1986; Taylor, 1987; Degernes et al., 1988; Cyr and Brunet, 1992; Avery, 1993b; Hochleithner, 1993

BIRDS, GENERAL PET

Weight: < 100 gm
Recommended Drug: 0.2 mg/gm ketamine
Supplemental Drug: 0.1 mg/gm ketamine

Weight: 100–500 gm
Recommended Drug: 0.1 mg/gm ketamine
Supplemental Drug: 0.05 mg/gm ketamine

Weight: 0.5–3 kg
Recommended Drug: 80 mg/kg ketamine
Supplemental Drug: 40 mg/kg ketamine

Weight: > 3 kg
Recommended Drug: 50 mg/kg ketamine
Supplemental Drug: 25 mg/kg ketamine
References: Kittle, 1971; Stunkard and Miller, 1974; Boever and Wright, 1975; Beck, 1976; Boever, 1979; Amand, 1980; Hartsfield, 1982; Cooper, 1984; Samour et al., 1984; Garver and Jackson, 1985; Linn, 1986; Schobert, 1987; Taylor, 1987; Heaton and Brauth, 1992; Felkai, 1993; Hochleithner, 1993

BISON, AMERICAN, *Bison bison*
Weight: 350–1,000 kg
Recommended Drug: 0.004 mg/kg carfentanil plus 0.07 mg/kg xylazine
Supplemental Drug: 0.004 mg/kg carfentanil
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
Alternative Drugs: 0.01 mg/kg etorphine plus 0.05 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 4.4 mg/kg Telazol®
References: Jarvis and Morris, 1960; Wallach et al., 1967; Wallach, 1968; 1969; Gauckler and Kraus, 1970; Jones, 1971; Thomas, 1961; Sedgwick and Acosta, 1969; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; Gray et al., 1974; Hertzog, 1975; Rapley and Mehren, 1975; Haigh, 1976d; Haugen et al., 1976; Wiesner, 1977; Jessup et al., 1980; Thorne, 1982; Wiesner et al., 1982; Carpenter and Lance, 1983; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Hugues et al., 1986; Sedgwick, 1986; Kock and Berger, 1987; Schobert, 1987; Williams and Riedesel, 1987; Berger and Kock, 1988; Renecker et al., 1992; Pond and O'Gara, 1994; Haigh and Gates, 1995

BISON, EUROPEAN, *Bison bonasus*
Weight: 350–1,000 kg
Recommended Drug: 1.5 mg carfentanil plus 35 mg xylazine
Supplemental Drug: If animal is not down in 20 min, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
Alternative Drugs: 0.01 mg/kg etorphine plus 0.5 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 1.8 ml Large Animal Immobilon® plus 50 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 2.5 mg/kg ketamine plus 0.08 mg/kg medetomidine; antagonize with 0.4 mg/kg atipamezole
References: Jaczewski and Swierzynski, 1955; Piwowarczyk, 1967; Zaniewski, 1967; Gauckler and Kraus, 1970; Göltenboth and Klös, 1970; Jones, 1971; Bauditz, 1972; Heck and Rivenburg, 1972; Kania et al., 1973; 1985; Kania and Teuchman, 1975; Rapley and Mehren, 1975; Wentges, 1975;

Wiesner, 1975; 1977; Krasinski et al., 1982; Wiesner et al., 1982; Duchamps, 1985; Wiesner and von Hegel, 1985; Sedgwick, 1986; Strauss, 1987; Kock et al., 1989; Jalanka and Roeken, 1990

BLACKBUCK, *Antilope cervicapra*

Weight: 32–43 kg

Recommended Drug: 6 mg/kg Telazol®

Supplemental Drug: 3 mg/kg ketamine

Antagonist: None

Alternative Drugs: 1.5 mg carfentanil; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given

- 2 mg/kg ketamine plus 0.25 mg/kg medetomidine; antagonize with 1 mg/kg atipamezole
- 4 mg/kg xylazine; antagonize with 0.2 mg/kg yohimbine (calm animals only)
- 0.3 ml Large Animal Immobilon® plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 3 mg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given

References: Larsen, 1963; Wright, 1963; Wallach et al., 1967; Wallach, 1968; 1969; Gauckler and Kraus, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; York and Huggins, 1972; Rapley and Mehren, 1975; Wiesner, 1977; Jones, 1978; Jessup et al., 1980; Wiesner et al., 1982; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Allen, 1986b; Hugues et al., 1986; Strauss, 1987; Williams and Riedesel, 1987; Arora, 1988; Jalanka and Roeken, 1990; Allen et al., 1991

BLESBOK, *Damaliscus dorcas*

Weight: 68–155 kg

Recommended Drug: 3 mg etorphine plus 5 mg xylazine

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

- 1.25 mg etorphine plus 15 mg ketamine plus 15 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 0.6 ml Large Animal Immobilon® plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 15 mg fentanyl plus 50 mg azaperone
- 8 mg/kg Telazol®

Comments: High impact darting systems should not be used.

References: Van Niekerk et al., 1963a; Pienaar, 1969b; 1973a; Bauditz, 1972; Heck and Rivenburg, 1972; Harthoorn and Van der Walt, 1974; De Vos, 1975; Röken, 1975; York, 1975; Haigh, 1976d; Hofmeyr, 1981; Wiesner et al., 1982;

Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Schobert, 1987; Williams and Riedesel, 1987; Allen et al., 1991; IWVS, 1992; Snyder et al., 1992; Burroughs, 1993d

BOBCAT, *Felis rufus*
Weight: 4.1–15.3 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine plus 1.5 mg/kg xylazine
• 20 mg/kg ketamine plus 0.1 mg/kg acepromazine
References: Kroll, 1962; Seal and Erickson, 1969; Seal et al., 1970; Bailey, 1971; Beck, 1976; Boever et al., 1977; Jessup et al., 1980; Hoilien and Oates, 1982; Jessup, 1982b; Fuller et al., 1985; Kocan et al., 1985; Schobert, 1987; Seal and Kreeger, 1987; Pond and O'Gara, 1994; Beltrán and Tewes, 1995

BONGO, *Tragelaphus eurycerus*
Weight: 150–200 kg
Recommended Drug: 2 mg carfentanil (males); 1.5 mg carfentanil (females)
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 0.023 mg/kg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
References: Röken, 1975; Gray, 1974; Haigh, 1976b; 1976d; Slee and Walker, 1977; Allen et al, 1991; Miller-Edge and Amsel, 1994

BONTEBOK - SEE BLESBOK

BUFFALO, AFRICAN, *Syncerus caffer*
Weight: 300–900 kg
Recommended Drug: 0.005 mg/kg carfentanil plus 0.05 mg/kg xylazine
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.05 mg/kg yohimbine
Alternative Drugs: 0.01 mg/kg etorphine plus 0.1 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.05 mg/kg yohimbine
• 5 mg/kg Telazol®
• 60 mg fentanyl plus 300 mg azaperone
Comments: Maintain in sternal recumbency. Change body position of large bulls every 10 minutes to maintain blood flow. If ambient temperature is >28° C, be prepared to cool the animal with water.
References: Buechner et al., 1960c; 1960d; Harthoorn and Lock, 1961; Talbot and Talbot, 1962; Van Niekerk et al., 1963a; Van Niekerk and Pienaar, 1963a; Condy, 1964; Graham-Jones, 1964; Pienaar et al., 1966a; Pienaar, 1968a; 1969a; 1969b; Jones, 1971; 1972; Bauditz, 1972; Harthoorn, 1972a;

1973a; 1973b; 1974; Heck and Rivenburg, 1972; Woodford et al., 1972; York and Huggins, 1972; Young and Whyte, 1973; Eltringham, 1974; Gray et al., 1974; Manton and Jones, 1974; De Vos, 1975; 1985; Rapley and Mehren, 1975; Röken, 1975; Smuts, 1975; York, 1975; Drager et al., 1976; Haigh, 1976d; Hattingh et al., 1984; Silvestris and Heck, 1984; Schobert, 1987; Kock et al., 1989; Allen et al., 1991; Janssen et al., 1991; IWVS, 1992; Bengis, 1993

BURRO - SEE ASS, WILD

BUSH BABY - SEE GALAGO

BUSHBUCK, *Tragelaphus scriptus*
Weight: 24–42 (f), 30–77 (m) kg
Recommended Drug: 12 mg/kg Telazol®
Supplemental Drug: 6 mg/kg ketamine
Antagonist: None
Alternative Drugs: 1 mg etorphine plus 100 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 15 mg fentanyl plus 80 mg azaperone
Comments: If captured by net first, immobilization can be achieved by administering 0.5 mg etorphine IV. Avoid high-impact darting systems.
References: Ebedes, 1962; Bauditz, 1972; Pienaar, 1973a; Röken, 1975; Smuts, 1975; Haigh, 1976d; Schobert, 1987; IWVS, 1992; Burroughs, 1993d

BUSH PIG, AFRICAN, *Potamochoerus porcus*
Weight: 46–130 kg
Recommended Drug: 2 mg/kg Telazol®
Supplemental Drug: 1 mg/kg Telazol®
Antagonist: None
Comments: Do not use etorphine in bush pigs.
References: Van Rensburg, 1993

CAIMAN - SEE CROCODILIANS, GENERAL

CAMEL, BACTRIAN, *Camelus bactrianus*
Weight: 300–690 kg
Recommended Drug: 2 mg/kg ketamine plus 2 mg/kg xylazine
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 1.5 mg/kg xylazine
Comments: Although opioids have been used on the Camelidae (Schels and Nowrouzian, 1977; Wiesner et al., 1982), some feel that their use is contraindicated (Jones, 1977a).
References: Gates, 1970; Bauditz, 1972; Jones, 1972; Heck and Rivenburg, 1972; Rapley and Mehren, 1975; Custer et al., 1977; Held and Paddleford,

1982; Wiesner et al., 1982; Higgins and Kock, 1984; Wiesner and von Hegel, 1985; Allen, 1986b; Kock et al., 1989; Jalanka and Roeken, 1990

CAMEL, DROMEDARY, *Camelus dromedarius*
Weight: 300–690 kg
Recommended Drug: 2 mg/kg ketamine plus 2 mg/kg xylazine
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 1.5 mg/kg xylazine
Comments: Although opioids have been used on the Camelidae (Schels and Nowrouzian, 1977; Wiesner et al., 1982), some feel that their use is contraindicated (Jones, 1977a).
References: Metcalfe, et al., 1968; Bhargava et al., 1969; Hime and Jones, 1970; Bauditz, 1972; Dennig, 1972; Gates, 1972; Heck and Rivenburg, 1972; Khamis et al., 1973; Alford et al., 1974; Rosborough et al., 1974; Hertzog, 1975; Mehren and Rapley, 1975; Rapley and Mehren, 1975; Röken, 1975; Schels and Nowrouzian, 1977; Peshin et al., 1980; 1992; Wiesner et al., 1982; Higgins and Kock, 1984; Jacobson and Kollias, 1984; Wiesner and von Hegel, 1985; Dioloi, 1992; Peshin et al., 1992; Singh et al., 1994

CAPYBARA, *Hydrochoerus hydrochaeris*
Weight: 27–79 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 0.1 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970; Szabuniewicz et al., 1978; Stoskopf, 1979; Wiesner and von Hegel, 1985

CARACAL, *Felis caracal*
Weight: 13–19 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 6.6 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine plus 1 mg/kg xylazine
References: Seal et al., 1970; Ebedes, 1973b; Genevois et al., 1984b; Gray et al., 1974; Schobert, 1987; McKenzie and Burroughs, 1993

CARIBOU, *Rangifer tarandus*
Weight: 80–318 kg
Recommended Drug: 1 mg/kg ketamine plus 0.07 mg/kg medetomidine
Supplemental Drug: 0.5 mg/kg ketamine
Antagonist: 0.35 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.06 mg/kg etorphine plus 0.3 mg/kg xylazine, antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 6 mg/kg ketamine plus 1.2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
- 5 mg/kg Telazol®
- 5 mg/kg xylazine; antagonize with 0.06 mg/kg idazoxan or 0.2 mg/kg yohimbine

Comments: Concentrated xylazine (300 mg/ml) worked better in darts than did the standard 100 mg/ml solution (Doherty and Tweedie, 1989).

References: Bergerud et al., 1964; Wallach et al., 1967; Wallach, 1968; 1969; Gauckler and Kraus, 1970; Des Meules et al., 1971; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; 1978; Laisher, 1972; Gray et al., 1974; Hertzog, 1975; Rapley and Mehren, 1975; Haigh, 1976d; 1978c; Wiesner, 1977; Jarofke, 1980; Fuller and Keith, 1981; Fong, 1982; Patenaude, 1982a; Thorne, 1982; Wiesner et al., 1982; Carpenter and Lance, 1983; Valkenburg et al., 1983; Jones, 1984; Röken, 1987; Schobert, 1987; Williams and Riedesel, 1987; Doherty and Tweedie, 1989; Kock et al., 1989; Jalanka, 1989d; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Tyler et al., 1990

CASSOWARY, DOUBLE-WATTLED, *Casuarius casuarius*

Weight: 40–85 kg

Recommended Drug: 10 mg etorphine plus 200 mg ketamine

Supplemental Drug: 2 mg etorphine plus 100 mg ketamine

Antagonist: 2 mg diprenorphine per mg etorphine given

References: Beck, 1976; Ensley, 1984; Stoskopf et al., 1982

CAT, BLACK-FOOTED, *Felis nigripes*

Weight: 1.5–2.75 kg

Recommended Drug: 4.4 mg/kg Telazol®

Supplemental Drug: 4.4 mg/kg ketamine

Antagonist: None

References: Seal et al., 1970

CAT, FISHING, *Felis viverrina*

Weight: 7.7–14 kg

Recommended Drug: 4.4 mg/kg Telazol®

Supplemental Drug: 4.4 mg/kg ketamine

Antagonist: None

Alternative Drugs: 22 mg/kg ketamine

References: Seal and Erickson, 1969; Seal et al., 1970; Dolensek, 1971; Beck, 1972; 1976; Gray et al., 1974; Jessup et al., 1980; Genevois et al., 1984b; Schobert, 1987

CAT, FLAT-HEADED, *Felis planiceps*

Weight: 1.6–2.1 kg

Recommended Drug: 8 mg/kg ketamine

Supplemental Drug: 4 mg/kg ketamine

Antagonist: None
References: Beck, 1972; 1976; Jessup et al., 1980

CAT, GEOFFREY, *Felis geoffroyi*
Weight: 3–7 kg
Recommended Drug: 4 mg/kg Telazol®
Supplemental Drug: 4 mg/kg ketamine
Antagonist: None
References: Seal et al., 1970; Gray et al., 1974; Schobert, 1987

CAT, ASIAN GOLDEN, *Felis temmincki*
Weight: 12–15 kg
Recommended Drug: 4 mg/kg ketamine plus 0.1 mg/kg medetomidine
Supplemental Drug: 2 mg/kg ketamine
Antagonist: 0.5 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 4.4 mg/kg Telazol®
References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Boever et al., 1977; Schobert, 1987; Jalanka and Roeken, 1990

CAT, JUNGLE, *Felis chaus*
Weight: 4–16 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 2.5 mg/kg ketamine plus 0.1 mg/kg medetomidine; antagonize with 0.5 mg/kg atipamezole
References: Graham-Jones, 1964; Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Boever et al., 1977; Genevois et al., 1984b; Schobert, 1987; Barnett and Lewis, 1990

CAT, LEOPARD, *Felis begalensis*
Weight: 3–7 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 6.6 mg/kg ketamine
Antagonist: None
Alternative Drugs: 22 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Hime, 1974; Beck, 1976; Boever et al., 1977; Genevois et al., 1984b; Schobert, 1987

CAT, PAMPAS, *Felis manul*
Weight: 3–7 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None

References: Gray et al., 1974; Genevois et al., 1984b; Schobert, 1987

CAT, SPOTTED, *Felis tigrina*
Weight: 1.75–2.75 kg
Recommended Drug: 8 mg/kg ketamine
Supplemental Drug: 4 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970

CAT, WILD, *Felis sylvestris*
Weight: 3–8 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Seal et al., 1970; Gray et al., 1974; Wiesner, 1977; Genevois et al., 1984b; Schobert, 1987

CAVY, PATAGONIAN, *Dolichatis patagonum*
Weight: 9–16 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine plus 12 mg/kg xylazine
References: Gray et al., 1974; Kock et al., 1989

CHAMOIS, *Rupricapra rupricapra*
Weight: 24–50 kg
Recommended Drug: 2 mg/kg ketamine plus 0.1 mg/kg medetomidine
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 0.5 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.013 mg/kg carfentanil plus 0.08 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
• 0.8 ml Large Animal Immobilon®; antagonize with 2 mg diprenorphine per mg etorphine given
• 0.05 mg/kg fentanyl plus 0.5 mg/kg xylazine; antagonize with 0.2 mg/kg naloxone plus 0.125 mg/kg yohimbine
References: Boch et al., 1961; Bauditz, 1972; Wiesner, 1977; Clarke and Henderson, 1979; Jensen, 1982; Wiesner et al., 1982; Duchamps, 1985; Jalanka and Roeken, 1990; Moran et al., 1994

CHEETAH, *Acinonyx jubatu*
Weight: 35–72 kg
Recommended Drug: 2.5 mg/kg ketamine plus 0.07 mg/kg medetomidine
Supplemental Drug: 1.5 mg/kg ketamine

Antagonist: 0.3 mg/kg atipamezole
Alternative Drugs: 5 mg/kg Telazol®
• 10 mg/kg ketamine plus 1 mg/kg xylazine
References: Young, 1966; Ericksen, 1968; Pienaar et al., 1969; Seal and Erickson, 1969; Ebedes, 1970; 1973b; Seal et al., 1970; Dolensek, 1971; Bauditz, 1972; Beck, 1972; 1976; York and Huggins, 1972; Holmes and Ngethe, 1973; Smuts et al., 1973; York, 1973; Alford et al., 1974; Gray et al., 1974; Hime, 1974; Wentges, 1975; Boever et al., 1977; Nair, 1977; Smeller and Bush, 1977; Wiesner, 1977; Jessup et al., 1980; Button et al., 1981; Genevois et al., 1984b; Wiesner and von Hegel, 1985; Schobert, 1987; Kock et al., 1989; Barnett and Lewis, 1990; IWVS, 1992; Klein and Stover, 1993; McKenzie and Burroughs, 1993

CHIMPANZEE, *Pan troglodytes*
Weight: 35–70 kg
Recommended Drug: 5 mg ketamine plus 0.05 mg/kg medetomidine
Supplemental Drug: 3 mg/kg ketamine
Antagonist: 0.2 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 10 mg/kg ketamine plus 1 mg/kg xylazine
• 5 mg/kg Telazol®
• 15 mg/kg ketamine
Comments: Smooth induction and good muscle relaxtion with ketamine/medetomidine.
References: Heuschele, 1959; Wallach et al., 1960; Marsboom et al., 1962; 1963; Larsen, 1963; Coetzee, 1964; Ericksen, 1968; Wallach et al., 1967; Wallach, 1968; 1969; Seal et al., 1970; Bauditz, 1972; Beck, 1972; Beck and Dresner, 1972; Gray et al., 1974; Bush et al., 1977; Vercruysse and Mortelmans, 1978; Jessup et al., 1980; April et al., 1982; Hugues et al., 1986; Robinson and Lambert, 1986; Göltenboth and Klös, 1987; Hess et al., 1987; Röken, 1987; Schobert, 1987; Kock et al., 1989; Jalanka and Roeken, 1990; Lewis, 1993

CHINCHILLA, *Chinchilla spp.*
Weight: 0.5–0.8 kg
Recommended Drug: 35 mg/kg Telazol®
Supplemental Drug: 20 mg/kg ketamine
Antagonist: None
Alternative Drugs: 40 mg/kg ketamine plus 0.5 mg/kg acepromazine
References: Gray et al., 1974; Schulz and Fowler, 1974; Morgan et al., 1981; Genevois et al., 1984a; Schobert, 1987

CHITAL - SEE DEER, AXIS

CHOUSINGHA - SEE FOUR-HORNED ANTELOPE

CIVET, AFRICAN PALM, *Nandinia binotata*
Weight: 1.7–2.1 kg
Recommended Drug: 8.8 mg/kg Telazol®
Supplemental Drug: 8.8 mg/kg ketamine
Antagonist: None
References: Seal et al., 1970; Gray et al., 1974; Beck, 1976; Genevois et al., 1984b; Schobert, 1987

CIVET, AFRICAN, *Civettictis civetta*
Weight: 7–20 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine plus 0.5 mg/kg xylazine
Comments: Darting of free-ranging civets is not recommended because they can easily become lost before the drug takes effect (McKenzie and Burroughs, 1993).
References: Seal and Erickson, 1969; Seal et al., 1970; McKenzie and Burroughs, 1993

CIVET, BANDED PALM, *Hemigalus derbyanus*
Weight: 1.75–3.0 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 6.6 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Gray et al., 1974; Schobert, 1987

CIVET, LESSER ORIENTAL, *Viverricula indica*
Weight: 2–4 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Genevois et al., 1984b; Schobert, 1987

CIVET, MALAGASY, *Fossa fossa*
Weight: 1.5–2 kg
Recommended Drug: 6 mg/kg Telazol®
Supplemental Drug: 6 mg/kg ketamine
Antagonist: None
References: Seal et al., 1970; Gray et al., 1974; Schobert, 1987

CIVET, MASKED PALM, *Paguma larvata*
Weight: 3.6–5 kg
Recommended Drug: 4 mg/kg Telazol®

Supplemental Drug: 4 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Schobert, 1987

CIVET, ORIENTAL, *Viverra zibetha*
Weight: 5–11 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970

CIVET, PALM, *Paradoxurus hermaphroditus*
Weight: 1.5–4.5 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Kroll, 1962; Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Genevois et al., 1984b; Schobert, 1987

COATIMUNDI, *Nasua spp.*
Weight: 3–6 kg
Recommended Drug: 20 mg/kg ketamine plus 1 mg/kg xylazine
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None reported
Alternative Drugs: 15 mg/kg ketamine plus 0.1 mg/kg acepromazine
Comments: Keep separate from other coatis for 24 hours after immobilization, if possible.
References: Graham-Jones, 1964; Dyson, 1965; Seal and Erickson, 1969; Seal et al., 1970; Beck, 1976; Jessup et al., 1980; Seal and Kreeger, 1987

COUGAR - SEE LION, MOUNTAIN

COYOTE, *Canis latrans*
Weight: 7–18 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Alternative Drugs: 10 mg/kg ketamine plus 0.1 mg/kg acepromazine
• 4 mg/kg ketamine plus 2 mg/kg xylazine, antagonize with 0.15 mg/kg yohimbine
Comments: If using xylazine, wait at least 45 min after last ketamine injection before administering yohimbine.
References: Kroll, 1962; Balser, 1965; Seal and Erickson, 1969; Seal et al., 1970; Bailey, 1971; Gray et al., 1974; Ramsden et al., 1976; Baer et al., 1978; Mulder, 1978a; Cornely, 1979; Hallett et al., 1979; Jessup et al., 1980; Hoilien

and Oates, 1982; Jessup, 1982b; Genevois et al., 1984b; Kreeger and Seal, 1986b; Schobert, 1987; Seal and Kreeger, 1987; Servin et al., 1990; Servin and Huxley, 1992; Pond and O'Gara, 1994

COYPU - SEE NUTRIA

CROCODILIANS, GENERAL

Recommended Drug: 15 mg/kg ketamine plus 1 mg/kg xylazine

Supplemental Drug: 8 mg/kg ketamine

Antagonist: None

Alternative Drugs: 15 mg/kg Telazol®

• 2 mg/kg gallamine; antagonize with 0.5 mg neostigmine per mg gallamine given but not to exceed 5 mg total

Comments: Expect prolonged induction times (20-30 min) when using either cyclohexane drug combination. Paralytic agents such as succinylcholine, gallamine, or atracurium may be more effective in crocodiles than other drugs. Decrease the dose of gallamine as size of crocodile increases (see Blake, 1993). Pole syringes are safe and effective means of drug delivery, although darts also can be used. Sites of injection are hind legs or the side of the tail just behind the hind legs.

References: Brisbin, 1966; Wallach and Hoessle, 1970; Calderwood, 1971; Klide and Klein, 1971; Loveridge and Blake, 1972; 1987; Woodford, 1972; Stunkard and Miller, 1974; Beck, 1976; Haigh, 1976d; Jones, 1977b; Terpin et al., 1978; Loveridge, 1979; Messel et al., 1980; Morgan-Davies, 1980; Lee, 1981; Jacobson, 1984; Spiegel et al., 1984a; 1984b; Idowu and Akinrinmade, 1985; Bonath et al., 1990; Clyde et al., 1990; Bennett, 1991; Johnson, 1991; Flamand et al., 1992; Blake, 1993; Page, 1993; Clyde et al., 1994; Lloyd et al., 1994

CRUSTACEANS (CRABS, LOBSTER, CRAYFISH)

Recommended Drug: 25 mg/kg procaine

Comments: Administer by injection with 27-gauge needle through a coxoarthrodial membrane of a walking leg (not a swimming appendage) into a lateral sinus.

References: Sedgwick, 1986

DEER, AXIS, *Axis axis*

Weight: 40–110 kg

Recommended Drug: 1.5 mg/kg ketamine plus 0.05 mg/kg medetomidine

Supplemental Drug: 1 mg/kg ketamine

Antagonist: 0.25 mg/kg atipamezole

Alternative Drugs: 4 mg/kg ketamine plus 4 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

• 0.004 mg/kg carfentanil plus 0.125 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

• 2.6 mg/kg Telazol®
• 1.7 ml Large Animal Immobilon® plus 30 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 3 mg fentanyl plus 24 mg azaperone plus 30 mg xylazine (i.e., Fentaz® plus xylazine); antagonize with 1 mg naloxone per mg fentanyl given plus 2 mg/kg tolazoline
• 3 mg/kg xylazine (calm animals only); antagonize with 0.2 mg/kg yohimbine
References: Jarvis and Morris, 1960; Thomas, 1961; Heuschele, 1961a; Kroll, 1962; Bauditz, 1972; Jones, 1972; Gray et al., 1974; Sutherland and Hodgkin, 1974; Rapley and Mehren, 1975; Nair, 1977; Presidente et al., 1978c; Keep, 1979; Jessup et al., 1980; Singh and Singh, 1982; Arora et al., 1983; Jones, 1984; Wiesner et al., 1982; 1984; Kock and Pearce, 1985; Wiesner and von Hegel, 1985; Karesh et al., 1986; Röken, 1987; Schobert, 1987; Seal and Bush, 1987; Arora, 1988; Franzmann and Lance, 1988; Van Mourik et al., 1988; Jalanka and Roeken, 1990; Arnemo et al., 1993c; Haigh et al., 1993

DEER, BLACK-TAILED - SEE DEER, MULE

DEER, BROCKET, *Mazama rufina*
Weight: 8–25 kg
Recommended Drug: 1 mg etorphine plus 5 mg ketamine plus 5 mg xylazine
Supplemental Drug: 15 mg ketamine IV, if possible
Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
References: Snyder et al., 1992

DEER, BROW-ANTLERED, *Cervus eldi*
Weight: 95–150 kg
Recommended Drug: 3 mg/kg Telazol® plus 0.3 mg/kg xylazine
Supplemental Drug: 1 mg/kg Telazol®
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 6 mg/kg Telazol®
• 0.06 mg/kg etorphine plus 0.25 mg/kg acepromazine; antagonize with 2 mg diprenorphine per mg etorphine given
References: Bush et al., 1992

DEER, CHINESE WATER, *Hydropotes inermis*
Weight: 11–30 kg
Recommended Drug: 0.06 mg/kg etorphine plus 0.25 mg/kg acepromazine
Supplemental Drug: If not down in 20 min, repeat full dose
Antagonist: 2 mg diprenorphine per mg etorphine given
Alternative Drugs: 7 mg/kg ketamine plus 7 mg/kg xylazine
References: Rapley and Mehren, 1975; Jones, 1978; 1984; Seal and Bush, 1987; Hastings et al., 1989; Kock et al., 1989

DEER, ELD'S - SEE DEER, BROW-ANTLERED

DEER, FALLOW, *Dama dama*

Weight: 40–100 kg

Recommended Drug: 2.5 mg/kg ketamine plus 0.1 mg/kg medetomidine

Supplemental Drug: 1.5 mg/kg ketamine

Antagonist: 0.5 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM

Alternative Drugs: 0.013 mg/kg carfentanil plus 0.125 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

- 4 mg/kg ketamine plus 3 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
- 20 mg/kg Telazol®
- 0.02 mg/kg etorphine plus 0.3 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 5 mg fentanyl plus 40 mg azaperone plus 50 mg xylazine (i.e., Fentaz® plus xylazine); antagonize with 1 mg naloxone per mg fentanyl given plus 2 mg/kg tolazoline

Comments: No entirely satisfactory combination of drugs has been found for the immobilization of fallow deer; be prepared for less-than-satisfactory immobilizations. The use of acepromazine is contraindicated in fallow deer because of hyperthermia and respiratory depression. Xylazine alone gives unpredictable results.

References: Pistey and Wright, 1959; Jarvis and Morris, 1960; Heuschele, 1961a; 1961b; Thomas, 1961; Wallach et al., 1967; Wallach, 1968; 1969; Eriksen, 1970; Gauckler and Kraus, 1970; Göltenboth and Klös, 1970; Honich, 1970; Klide and Klein, 1971; Mulling and Henning, 1971; Bauditz, 1972; Fessel, 1972; Jones, 1972; 1978; Heck and Rivenburg, 1972; Chapman, 1973; Kilde and Klein, 1973; York and Huggins, 1972; Scanlon, 1973; Woolf et al., 1973; Alford et al., 1974; Gray et al., 1974; Harrington, 1974; Done et al., 1975; Hertzog, 1975; Rapley and Mehren, 1975; Geiger, 1976; Haigh, 1976d; 1977; Wiesner, 1977; Presidente et al., 1978b; Keep, 1979; Pertz and Sundberg, 1978; Jarofke, 1980; Jessup, et al., 1980; Schulz and Dingeldein, 1980; Wiesner et al., 1982; 1984; Jones, 1984; Silvestris and Heck, 1984; Duchamps, 1985; Kock and Pearce, 1985; Pearce et al., 1985; Wiesner and von Hegel, 1985; Hugues et al., 1986; Röken, 1987; Schobert, 1987; Seal and Bush, 1987; Williams and Riedesel, 1987; Sancken and Fischer, 1988; Van Mourik et al., 1988; Kock et al., 1989; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Allen et al., 1991; Tung et al., 1993

DEER, HIMALAYAN MUSK, *Moschus chrysogasters*

Weight: 7–17 kg

Recommended Drug: 4.5 mg/kg ketamine plus 1.5 mg/kg xylazine

Supplemental Drug: 2.5 mg/kg ketamine

Antagonist: 0.125 mg/kg yohimbine

References: Green, 1986; Kattel and Alldredge, 1991

DEER, HOG, *Axis porcinus*

Weight: 27–110 kg

Recommended Drug: 0.45 mg carfentanil

Supplemental Drug: If animal is not down in 20 min, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given

Alternative Drugs: 4 mg/kg xylazine; antagonize with 0.2 mg/kg yohimbine (calm deer only)

References: Göltenboth and Klös, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; Presidente et al., 1978b; Keep, 1979; Jarofke, 1980; Singh and Singh, 1982; Jones, 1984; Dhungel, 1985 Allen et al., 1991

DEER, MULE, *Odocoileus hemionus*

Weight: 75–200 kg

Recommended Drug: 4.4 mg/kg Telazol® plus 2.2 mg/kg xylazine

Supplemental Drug: 2.2 mg/kg ketamine

Antagonist: 0.125 mg/kg yohimbine

Alternative Drugs: 7 mg/kg ketamine plus 0.7 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

- 0.03 mg/kg carfentanil plus 0.7 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
- 15 mg/kg Telazol®
- 3 mg etorphine plus 30 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 3 mg/kg xylazine, antagonize with 0.2 mg/kg yohimbine (calm deer only)

Comments: Deer immobilized with etorphine may run long distances and/or have an extended period (10+ min) of hyperactivity before recumbency. This hyperactivity can result in hyperthermia. All opioid agents can result in respiratory depression. When using ketamine-xylazine or Telazol®-xylazine for highly excited deer, the xylazine dose can be increased up to the dose of ketamine or Telazol® given (i.e., 7 mg/kg or 4.4 mg/kg, respectively).

References: Heuschele, 1959; 1961a; 1961b; Jarvis and Morris, 1960; Anderson, 1961; Boyd, 1962; Cowan et al., 1962; Kroll, 1962; Merriam, 1962; Nordan et al., 1962; Pearson et al., 1963; Denney, 1965; Dyson, 1965; Siglin, 1965; Wolff et al., 1965; Kitchen, 1966; Miller, 1968; Day, 1969; Heck and Rivenburg, 1972; Dean et al., 1973; Gray et al., 1974; Rapley and Mehren, 1975; Haigh, 1976d; Richter, 1977; Wiesner, 1977; Trindle and Lewis, 1978; Jarofke, 1980; Lange, 1982; Jessup et al., 1980; 1982a; 1983; 1984; 1985a; Thorne, 1982; Carpenter and Lance, 1983; Jacobsen, 1983; Gullett, 1984; Krausman et al., 1984; Seidel and Strauss, 1984; Renecker and Olsen, 1985; Krausman et al., 1986; Schobert, 1987; Seal and Bush, 1987; Williams and Riedesel, 1987; Franzmann and Lance, 1988; Greene, 1988; DelGiudice et al., 1989; Smits et al., 1989

DEER, PAMPAS, *Ozotoceros bezoarticus*

Weight: 25–40 kg

Recommended Drug: 0.3 ml Large Animal Immobilon®

Supplemental Drug: If not down in 20 min, repeat full dose

Antagonist: 2 mg diprenorphine per mg etorphine given

References: Wiesner et al., 1982

DEER, PÉRE DAVID'S, *Elaphurus davidianus*

Weight: 159–214 kg

Recommended Drug: 1 mg/kg ketamine plus 0.03 mg/kg medetomidine

Supplemental Drug: 0.5 mg/kg ketamine

Antagonist: 0.15 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM

Alternative Drugs: 3 mg/kg Telazol® plus 0.2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

- 5 mg/kg Telazol®
- 0.03 mg/kg etorphine plus 0.2 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 1 mg/kg xylazine; antagonize with 0.2 mg/kg yohimbine (calm deer only)

References: Heck and Rivenburg, 1972; Jones, 1972; 1978; Rapley and Mehren, 1975; Smeller et al., 1976; Wiesner, 1977; Jarofke, 1980; Bush, 1982; Jacobson and Kollias, 1984; Jensen, 1982; Wiesner et al., 1982; Jacobson and Kollias, 1984; Jones, 1984; Kock and Pearce, 1985; Seal and Bush, 1987; Kock et al., 1989; Jalanka and Roeken, 1990; Bush et al., 1992; Lu et al., 1992

DEER, RED, *Cervus elaphus*

Weight: 60–180 kg

Recommended Drug: 2.2 mg/kg ketamine plus 0.11 mg/kg medetomidine

Supplemental Drug: 1.1 mg/kg ketamine

Antagonist: 0.5 mg/kg atipamezole

Alternative Drugs: 4 mg/kg ketamine plus 4 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

- 0.004 mg/kg carfentanil plus 0.15 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
- 0.024 mg/kg etorphine plus 0.1 mg/kg acepromazine; antagonize with 2 mg diprenorphine per mg etorphine given
- 0.21 mg/kg fentanyl plus 1.7 mg/kg azaperone
- 3 mg/kg xylazine, antagonize with 0.125 mg/kg yohimbine (calm deer only)
- 0.08 mg/kg medetomidine, antagonize with 0.3 mg/kg atipamezole (calm deer only)

References: Boch et al., 1961; Thomas, 1961; Jewell et al., 1965; Jewell and Lowe, 1965; Taylor and Magnussen, 1965; Eriksen, 1968b; Eriksen, 1970; Gauckler and Kraus, 1970; Honich, 1970; Mulling and Henning, 1971; Bauditz, 1972; Fessel, 1972; Heck and Rivenburg, 1972; Jones, 1972; 1978; Woolf et al., 1973; Fletcher, 1974; 1986; McAllum, 1977; Wiesner, 1977;

Presidente et al., 1978b; Keep, 1979; Jarofke, 1980; Van Reenen, 1982; Wiesner et al., 1982; 1984; Dickson et al., 1983; Simpson et al., 1983; Jones, 1984; MacKintosh and Van Reenen, 1984a; 1984b; Duchamps, 1985; Kock and Pearce, 1985; McKelvey and Simpson, 1985; Wiesner and von Hegel, 1985; Sedgwick, 1986; Röken, 1987; Seal and Bush, 1987; Cross et al., 1988; Koubek and Mrlik, 1988; Van Mourik et al., 1988; Kock et al., 1989; Jalanka and Roeken, 1990; Haigh and Hudson, 1993; Zomborszky et al., 1993; Arnemo et al., 1994b

DEER, ROE, *Capreolus capreolus*

Weight: 15–50 kg

Recommended Drug: 5 mg/kg ketamine plus 3 mg/kg xylazine

Supplemental Drug: 2.5 mg/kg ketamine

Antagonist: 0.15 mg/kg yohimbine

Alternative Drugs: 1.5 mg/kg ketamine plus 0.05 mg/kg medetomidine; antagonize with 0.25 mg/kg atipamezole

- 0.6 mg carfentanil; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given
- 0.3 ml Large Animal Immobilon® plus 5 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 0.002 mg/kg etorphine plus 0.2 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 3 mg/kg xylazine; antagonize with 0.2 mg/kg yohimbine (calm deer only)

References: Gauckler and Kraus, 1970; Marma, 1970; Mulling and Henning, 1971; Blazhis et al., 1972; Fessel, 1972; Heck and Rivenburg, 1972; Rapley and Mehren, 1975; Schultze, 1976; Wiesner, 1977; Keep, 1979; Jarofke, 1980; Wiesner et al., 1982; Jones, 1984; Seidel and Strauss, 1984; Duchamps, 1985; Röken, 1987; Seal and Bush, 1987; Jalanka and Roeken, 1990; Allen et al., 1991

DEER, RUSA - SEE SAMBAR, SUNDA

DEER, SIKA, *Cervus nippon*

Weight: 40–80 kg

Recommended Drug: 2.5 mg/kg ketamine plus 3 mg/kg xylazine

Supplemental Drug: 1.25 mg/kg ketamine

Antagonist: 0.125 mg/kg yohimbine

Alternative Drugs: 2.3 mg/kg ketamine plus 0.23 mg/kg medetomidine; antagonize with 1 mg/kg atipamezole

- 5 mg/kg Telazol®
- 0.01 mg/kg carfentanil; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given
- 0.05 mg/kg etorphine plus 0.2 mg/kg acepromazine; antagonize with 2 mg diprenorphine per mg etorphine given
- 4 mg/kg xylazine; antagonize with 0.2 mg/kg yohimbine (calm deer only)

References: Jarvis and Morris, 1960; Heuschele, 1961a; Thomas, 1961; Seal and Erickson, 1969; Eriksen, 1970; Gauckler and Kraus, 1970; Göltenboth and Klös, 1970; Seal et al., 1970; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; 1978; 1984; York and Huggins, 1972; Woolf et al., 1973; Gray et al., 1974; Rapley and Mehren, 1975; Haigh, 1976d; Wiesner, 1977; Paponov, 1978; Keep, 1979; Jarofke, 1980; Arora et al., 1983; Jacobson and Kollias, 1984; Silvestris and Heck, 1984; Kock and Pearce, 1985; Wiesner and von Hegel, 1985; Zabarain, 1985; Allen, 1986b; Schobert, 1987; Seal and Bush, 1987; Strauss, 1987; Barnett and Lewis, 1990; Allen et al., 1991; Tung et al., 1993

DEER, SWAMP - SEE BARASINGHA

DEER, TIMOR - SEE SAMBAR, SUNDA

DEER, WHITE-TAILED, *Odocoileus virginianus*

Weight: 60–150 kg

Recommended Drug: 4.4 mg/kg Telazol® plus 2.2 mg/kg xylazine

Supplemental Drug: 2.2 mg/kg ketamine

Antagonist: 0.125 mg/kg yohimbine

Alternative Drugs: 7.5 mg/kg ketamine plus 1.5 mg/kg xylazine, antagonize with 0.125 mg/kg yohimbine

- 2 mg/kg ketamine plus 0.07 mg/kg medetomidine; antagonize with 0.35 mg/kg atipamezole
- 6 mg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
- 3 mg/kg xylazine, antagonize with 0.2 mg/kg yohimbine (calm deer only)

Comments: When using xylazine alone, young deer (< 1 yr) may require higher doses (i.e., 6 mg/kg; Bubenick, 1982). Immobilization with xylazine alone is unreliable, particularly when the animal is excited or has been chased. When using ketamine-xylazine or Telazol®-xylazine for highly excited deer, the xylazine dose can be increased up to the dose of ketamine or Telazol® given (i.e., 7.5 mg/kg or 4.4 mg/kg, respectively). Deer immobilized with etorphine may run long distances and/or have an extended period (10+ min) of hyperactivity before recumbency. This hyperactivity can result in hyperthermia. All opioid agents can result in respiratory depression.

References: Severinghaus, 1950; Hall et al., 1953; Jenkins et al., 1955; Crockford et al., 1957a; 1957b; Feurt et al., 1958; Jarvis and Morris, 1960; Montgomery, 1961; Cowan et al., 1962; Nordan et al., 1962; Green, 1963; Murry and Dennett, 1963; Murray, 1964; 1965; Thomas and Marburger, 1964; Behrend, 1965; Dyson, 1965; Kitchen, 1966; Fletch et al., 1967; Hawkins et al., 1967; 1968; Montgomery and Hawkins, 1967; Thomas et al., 1967; Day, 1969b; Liscinsky et al., 1969; Seal and Erickson, 1969; Short, 1969; Allen, 1970; Göltenboth and Klös, 1970; Seal et al., 1970; 1972; Woolf, 1970; 1974; Bauditz, 1972; Beck, 1972; Heck and Rivenburg, 1972; York and Huggins, 1972; Dean et al., 1973; Presidente et al., 1973; 1978a; 1978b; Presnell et al.,

1973; Woolf et al., 1973; Gray et al., 1974; Scanlon and Mirarchi, 1974; Wesson et al., 1974; 1976; 1979a; 1979b; Hertzog, 1975; Rapley and Mehren, 1975; Roughton, 1975; Haigh, 1976d; Jacobsen et al., 1976; Scanlon et al., 1977; Wiesner, 1977; Jones, 1978; 1984; Presidente and Draisma, 1978; Gibson et al., 1979; 1980a; 1980b; 1982; Hawkins et al., 1979; Jarofke, 1980; Kocan et al., 1980; 1981; Mautz et al., 1980; Kopf et al., 1981a; 1981b; Bubenik, 1982; Jensen, 1982; Nielsen, 1982; Thorne, 1982; Carpenter and Lance, 1983; Jensen, et al., 1983; Samuelson, 1983; Chao et al., 1984; Hsu and Shulaw, 1984; Mech et al., 1984; 1985; Silvestris and Heck, 1984; Scanlon and Brunjak, 1984; Warren et al., 1984; Renecker and Olsen, 1985; Scanlon and Vaughan, 1985; Zabarain, 1985; Van Der Eems and Brown, 1986; Kreeger et al., 1986a; 1986b; 1987b; DelGiudice et al., 1986; Schobert, 1987; 1988; Seal and Bush, 1987; Strauss, 1987; Williams and Riedesel, 1987; Dew, 1988; Diehl, 1988; Green, 1988; Bubenik and Brown, 1989; Smits and Haigh, 1989; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Pond and O'Gara, 1994; Wallingford et al., 1996

DEGU, *Octodon degus*
Weight: 170–300 gm
Recommended Drug: 40 mg/kg ketamine plus 1 mg/kg diazepam
Supplemental Drug: 20 mg/kg ketamine only
Antagonist: None
References: Stoskopf, 1979

DEVIL, TASMANIAN, *Sarcophilus harrisii*
Weight: 4.1–11.8 kg
Recommended Drug: 5.5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 4.5 mg/kg ketamine plus 0.6 mg/kg xylazine
References: Denny, 1974; Gray et al., 1974; Smeller et al., 1977; Schobert, 1987; Bush et al., 1990; Pemberton and Gales, 1991; Holz, 1992

DHOLE, *Cuon alpinus*
Weight: 10–21 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine

DIK-DIK, *Madoqua kirki*
Weight: 3–7 kg
Recommended Drug: 3 mg fentanyl plus 5 mg azaperone
Supplemental Drug: 1.5 mg fentanyl
Antagonist: 0.2 mg/kg naloxone
Alternative Drugs: 6 mg/kg Telazol®

• 0.2 mg/kg fentanyl plus 0.4 mg/kg xylazine
• 0.01 mg/kg etorphine plus 0.4 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: Monitor for respiratory depression when using opioids.
References: Hofmeyr, 1981; IWVS, 1992; Burroughs, 1993d

DINGO, *Canis dingo*
Weight: 12–15 kg
Recommended Drug: 5 mg/kg ketamine plus 2 mg/kg xylazine, antagonize with 0.15 mg/kg yohimbine
Supplemental Drug: 2.5 mg/kg ketamine
Alternative Drugs: 10 mg/kg Telazol®
• 10 mg/kg ketamine plus 0.1 mg/kg acepromazine
• 0.04 mg/kg etorphine plus 1 mg/kg promazine, antagonize with 2 mg diprenorphine per mg etorphine given
Comments: If using xylazine, wait at least 45 min after last ketamine injection before administering yohimbine.
References: Heuschele, 1961a; 1961b; Wentges, 1975; Wiesner, 1975; Green, 1976; Hess and Knakal, 1985

DOG, BUSH, *Speothos venaticus*
Weight: 5–7 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970

DOG, AFRICAN HUNTING, *Lycaon pictus*
Weight: 17–36 kg
Recommended Drug: 5 mg/kg ketamine plus 0.05 mg/kg medetomidine
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: 0.15 mg/kg atipamezole
• 0.1 mg/kg fentanyl plus 1 mg/kg xylazine; antagonize with 0.04 mg/kg naloxone and 0.125 mg/kg yohimbine
• 2 mg/kg ketamine plus 2 mg xylazine; antagonize with 0.2 mg/kg yohimbine
Comments: Monitor anesthetized animals for hyperthermia. The fentanyl/xylazine dose is highly recommended by Van Heerden (1993) for immobilizing free-ranging adult animals.
References: Kroll, 1962; Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Ebedes and Grobler, 1979; Van Heerden and de Vos, 1981; Genevois et al., 1984b; Schobert, 1987; Kock et al., 1989; Van Heerden et al., 1991a; 1991b; Vahala, 1993; Van Heerden, 1993; Osofsky et al., 1995; Raath et al., 1995

DOG, FERAL DOMESTIC, *Canis lupus familiaris*
Weight: 5–50 kg
Recommended Drug: 10 mg/kg ketamine plus 1 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine only
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 10 mg/kg Telazol®
References: Ortega and Otter, 1967; McWade, 1982

DOG, RACCOON, *Nyctereutes procyonoides*
Weight: 5–8.5 kg
Recommended Drug: 5 mg/kg ketamine plus 0.1 mg/kg medetomidine
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: 1 mg/kg atipamezole
Alternative Drugs: 6.6 mg/kg Telazol®
• 20 mg/kg ketamine plus 2 mg/kg promazine
Comments: Monitor body temperature for hypo/hyperthermia during periods of extreme ambient temperatures.
References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Schobert, 1987; Arnemo et al., 1993a

DOG, SMALL-EARED, *Atelocynus microtis*
Weight: 9–10 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 2 mg/kg promazine
References: Seal et al., 1970

DOLPHIN, BOTTLENOSED, *Tursiops truncatus*
Weight: 150–200 kg
Recommended Drug: 0.23 mg/kg meperidine
Alternative Drugs: 5.5 mg/kg propofol, IV
References: Ridgway and McCormick, 1967; Ridgway et al., 1975; Meshcherskii et al., 1978; Joseph and Cornell, 1988; Reynolds, 1992

DOUROUCOULIS, *Aotus spp.*
Weight: 0.6–1 kg
Recommended Drug: 9 mg/kg ketamine
Supplemental Drug: 4.5 mg/kg ketamine
Antagonist: None
References: Bush et al., 1977

DUCK, MALLARD, *Anas platyrhynchos*
Weight: 1–1.3 kg
Recommended Drug: 50 mg/kg Telazol®
Supplemental Drug: 25 mg/kg ketamine

Antagonist: None
Alternative Drugs: 40 mg/kg alpha-choralose given orally
Comments: Oral administration of immobilizing drugs is generally an ineffective method of capturing birds, but may be employed when no other alternatives exist. Be prepared for extreme variability of effects, ranging from little or no sedation to relatively high mortality.
References: Crider et al., 1968; Crider and McDaniel, 1968; Cline and Greenwood, 1972; Krapu, 1976; Gordon, 1977; Camburn and Stead, 1978; Hofman and Weaver, 1980; Schobert, 1987

DUCK, MUSCOVY, *Cairina moschata*
Weight: 1.1–4 kg
Recommended Drug: 15 mg/kg Telazol®
Supplemental Drug: 15 mg/kg ketamine
Antagonist: None
Comments: Muscovy ducks may be sensitive to Telazol® dose. Insure that body weight is accurate.
References: Crider et al., 1968; Schobert, 1987

DUIKER, BLACK, *Cephalophorus niger*
Weight: 20–40 kg
Recommended Drug: 0.026 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 0.02 mg/kg etorphine plus 1 mg/kg xylazine
Comments: Monitor for respiratory depression when using opioids.
References: Haigh, 1976d

DUIKER, BLUE, *Cephalophorus monticola*
Weight: 3.5–9 kg
Recommended Drug: 2.2 mg/kg ketamine plus 0.2 mg/kg medetomidine
Supplemental Drug: 1.1 mg/kg ketamine
Antagonist: 1 mg/kg atipamezole
Alternative Drugs: 3 mg fentanyl plus 5 mg azaperone; antagonize with 0.2 mg/kg naloxone
- 6 mg/kg Telazol®
- 0.2 mg/kg fentanyl plus 0.4 mg/kg xylazine
- 0.01 mg/kg etorphine plus 0.4 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Comments: Monitor for respiratory depression when using opioids.
References: IWVS, 1992; Burroughs, 1993d; Bailey et al., 1995

DUIKER, COMMON (GRAY), *Silivicapra grimmia*
Weight: 12–25 kg
Recommended Drug: 10 mg/kg Telazol®

Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 0.01 mg/kg etorphine plus 0.4 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: Monitor for respiratory depression when using opioids.
References: Wilson, 1967; Haigh, 1976d; Hofmeyr, 1981; Schobert, 1987; IWVS, 1992; Burroughs, 1993d; Nicholls et al., 1996

DUIKER, JENTINK'S, *Cephalophorus jentinki*
Weight: 20–40 kg
Recommended Drug: 0.026 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Comments: Monitor for respiratory depression when using opioids.
References: Haigh, 1976d

DUIKER, MAXWELL'S, *Cephalophorus maxwelli*
Weight: 10–15 kg
Recommended Drug: 0.026 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 10 mg/kg Telazol®
• 0.02 mg/kg etorphine plus 1 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: Monitor for respiratory depression when using opioids.
References: Bauditz, 1972; Haigh, 1976d; Schobert, 1987

DUIKER, RED, *Cephalophorus natalensis*
Weight: 20–40 kg
Recommended Drug: 5 mg fentanyl plus 5 mg azaperone
Supplemental Drug: 2.5 mg fentanyl
Antagonist: 0.2 mg/kg naloxone
Alternative Drugs: 6 mg/kg Telazol®
• 0.2 mg/kg fentanyl plus 0.4 mg/kg xylazine
• 0.01 mg/kg etorphine plus 0.4 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
References: IWVS, 1992; Burroughs, 1993d

DUIKER, RED-FLANKED, *Cephalophorus rufilatus*
Weight: 20–40 kg
Recommended Drug: 0.026 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg etorphine given
Alternative Drugs: 0.02 mg/kg etorphine plus 1 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Comments: Monitor for respiratory depression when using opioids.
References: Young and Whyte, 1973; Haigh, 1976d

DUIKER, YELLOW-BACK, *Cephalophorus sylvicultor*
Weight: 45–80 kg
Recommended Drug: 0.026 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg etorphine given
Alternative Drugs: 0.02 mg/kg etorphine plus 1 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: Monitor for respiratory depression when using opioids.
References: Haigh, 1976d

DUIKER, ZEBRA, *Cephalophorus zebra*
Weight: 20–40 kg
Recommended Drug: 0.026 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg etorphine given
Alternative Drugs: 0.02 mg/kg etorphine plus 1 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: Monitor for respiratory depression when using opioids.
References: Haigh, 1976d

EAGLE, BALD, *Haliaetus leucocephalus*
Weight: 3–4 kg
Recommended Drug: 15 mg/kg Telazol®
Supplemental Drug: 15 mg/kg ketamine
Antagonist: None
References: Schobert, 1987; Aguilar et al., 1996

EAGLE, GOLDEN, *Aguila chrysaetos*
Weight: 3.5–5 kg
Recommended Drug: 44 mg/kg ketamine
Supplemental Drug: 22 mg/kg ketamine
Antagonist: None
References: Haupert and Lindeen, 1974; Frank and Cooper, 1974; Beck, 1976, Clutton, 1986

ECHIDNA, *Tachyglossus aculeatus*
Weight: 2.5–6 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Denny, 1974; Shima et al., 1993

ELAND, *Taurotragus oryx*

Weight: 400–1,000 kg

Recommended Drug: 0.008 mg/kg carfentanil plus 0.2 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 min, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.1 mg/kg yohimbine

Alternative Drugs: 0.02 mg/kg etorphine plus 0.4 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 4 mg/kg ketamine plus 0.8 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
- 11.5 mg/kg Telazol®
- 3 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine (calm animals only)

Comments: Prone to excessive running during induction with opioids, particularly if underdosed; monitor for hyperthermia. Do not use opioids without xylazine or similar neuroleptic. Semi-immobilized animals can be aggressive towards humans.

References: Pistey and Wright, 1959; Jarvis and Morris, 1960; Thomas, 1961; Larsen, 1963; Van Niekerk et al., 1963a; Wright, 1963; Bigalke, 1965; Hirst et al., 1965; Pienaar et al., 1966a; Wallach et al., 1967; Keep and Keep, 1968; Wallach, 1968; 1969; Pienaar, 1968a; 1969b; 1973a; Gauckler and Kraus, 1970; Harthoorn, 1971; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; York and Huggins, 1972; Abbott, 1973; Smuts, 1973; Woolf et al., 1973; Young and Whyte, 1973; Drevemo and Karstad, 1974; Manton and Jones, 1974; De Vos, 1975; Hertzog, 1975; Röken, 1975; York, 1975; Grootenhuis et al., 1976; Haigh, 1976d; Jones, 1977; Slee and Walker, 1977; Hofmeyr, 1981; Jensen, 1982; Janssen and Oosterhuis, 1984; Silvestris and Heck, 1984; Sedgwick, 1986; Schobert, 1987; Williams and Riedesel, 1987; Allen et al., 1991; Janssen et al., 1991; IWVS, 1992; Burroughs, 1993d

ELEPHANT, AFRICAN, *Loxodonta africana*

Weight: 2,000–4,000 (f), 4,000–6,000 (m) kg

Recommended Drug: 0.0021 mg/kg carfentanil

Supplemental Drug: 0.0005 mg/kg carfentanil

Antagonist: 0.08 mg/kg naltrexone or nalmefene

Alternative Drugs: 0.003 mg/kg etorphine; antagonize with 3 mg diprenorphine per mg etorphine given

- 1.14 mg/kg ketamine plus 0.14 mg/kg xylazine; antagonize with 0.13 mg/kg yohimbine
- 3 mg/kg Telazol®

Comments: Hyaluronidase may be added (4,500 IU) to hasten induction. When using high doses of etorphine, you may wish to add azaperone at 10 times the etorphine dose to decrease the incidence of "pink foam" syndrome. Tranquilizers need not be added to opioids because they may prolong recovery. However, azaperone (50 mg in an adult bull) should probably be given

IV after the animal has become immobilized to decrease the high mean arterial blood pressure apparently caused by opioids which can result in lung edema and capillary bleeding (see Raath, 1993). Dart needles should be ≥ 60 mm in length and 3 mm in diameter. Avoid shoulder shots which may strike the ear or the dart may be reached and pulled out by the trunk. Place immobilized elephant in lateral recumbency; do not allow animal to remain in sternal recumbency. Insure that breathing through the trunk is unimpaired. Body temperature ranges from 37–39.9° C (96.3–99.5° F), but may decline during immobilization to 35° C (95° F). The Telazol® dose was derived from a single, successful immobilization; the elephant was recumbent in 2 min and recovered in 6 hr. Agitated or aggressive animals may require higher doses of recommended drug. Be sure to flush all dart wounds with antimicrobial solution to prevent abcesses. The mother of a calf to be immobilized must also be immobilized because she will not leave it.

References: Harthoorn, 1960; 1963d; 1965a; 1972a; 1973a; 1973b; 1974; 1976; Harthoorn et al., 1961; Harthoorn and Luck, 1962; Pienaar, 1963; 1967b; 1969a; 1969b; Harthoorn and Bligh, 1965; Somers, 1965; Pienaar et al., 1966a; 1966b; Ericksen, 1968; Pienaar, 1968a; Wallach, 1968; 1969; Wallach and Anderson, 1968; Lietsch, 1969; Woodford et al., 1972; Young, 1972; Alford et al., 1974; Elder and Rogers, 1974; Eltringham, 1974; Gray et al., 1974; De Vos, 1975; 1985a; Ebedes, 1975b; Röken, 1975; Smuts, 1975; Haigh, 1976d; Silberman, 1977; Haigh et al., 1979; Fowler, 1981b; Wiesner et al., 1982; Tamas and Geiser, 1983; Dunlop et al., 1984; Hattingh et al., 1984; Jacobson and Kollias, 1984; Bengis et al., 1985; Jacobson et al., 1985; 1986; 1987; 1988; Trembath, 1985; Wiesner and von Hegel, 1985; Allen, 1986a; 1986b; Heard et al., 1986; 1988; Göltenboth and Klös, 1987; Schobert, 1987; Kock et al., 1989; Welsch et al., 1989; Janssen et al., 1991; IWVS, 1992; Kock et al., 1993; Raath, 1993; Still, 1993; Hattingh et al., 1994a; 1994b; Osofsky, 1995; Schumacher et al., 1996

ELEPHANT, ASIAN, *Elaphus maximus*

Weight: 2,300–3,700 kg (f), 3,700–4,500 (m) kg

Recommended Drug: 0.003 mg/kg etorphine

Supplemental Drug: 2 mg etorphine, as needed to maintain immobilization

Antagonist: 0.012 mg/kg diprenorphine

Alternative Drugs: 3.25 ml Large Animal Immobilon®; antagonize with 2 mg diprenorphine per mg etorphine given

Comments: Xylazine alone (0.1 mg/kg) is capable of producing profound sedation (see Bongso, 1979; Schmidt, 1975; 1983). Hyaluronidase may be added (4,500 IU) to hasten induction. Immobilized elephants suffer fewer respiratory problems when in lateral, as opposed to sternal, recumbency. Body temperature ranges from 37–39.9° C (96.3–99.5° F), but may decline during immobilization to 35° C (95° F).

References: Kodituwakku et al., 1961; Larsen, 1963; Wallach, 1969; Gray and Nettashinghe, 1970; Jainudeen, 1970; Jainudeen et al., 1971; Fowler, 1973;

1981b; Fowler and Hart, 1973; Alford et al., 1974; Schmidt, 1975a; 1975b; 1985; Jainudeen and Khan, 1977; Bongso et al., 1978; Bongso 1979; 1980; Muraleedharan et al., 1979; Jarofke, 1981a; 1981b; Byron et al., 1985; Lateur and Stolk, 1986; Sale, et al., 1986; Göltenboth and Klös, 1987; Kock et al., 1993; Johnsingh et al., 1993; Silva and Kuruwita, 1993

ELK, NORTH AMERICAN, *Cervus elaphus*

Weight: 230–318 kg

Recommended Drug: 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 min, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine IV

Alternative Drugs: 2 mg/kg ketamine plus 0.07 mg/kg medetomidine; antagonize with 0.35 mg/kg atipamezole

- 3 mg/kg Telazol® plus 0.4 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
- 4 mg/kg ketamine plus 2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
- 2 mg/kg xylazine, antagonize with 0.125 mg/kg yohimbine (calm or captive elk only)
- 6 mg etorphine plus 50 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Comments: Monitor elk carefully for overheating or bloat. Underdosing with etorphine can cause hyperexcitability; use a minimum of 0.02 mg/kg etorphine. For highly excited elk, the carfentanil dose can be increased to 0.013 mg/kg; the xylazine dose remains the same (i.e., 0.1 mg/kg).

References: Post, 1959; Heuschele, 1961a; Thomas, 1961; Flook et al., 1962; Larsen, 1963; Harper, 1964; 1965; Denney, 1965; 1966; Day, 1969; Seal and Erickson, 1969; Sedgwick and Acosta, 1969; Gauckler and Kraus, 1970; Seal et al., 1970; Woolf and Swart, 1970; Guinness et al., 1971; Bauditz, 1972; Heck and Rivenburg, 1972; Thurmon et al., 1972; York and Huggins, 1972; Woolf et al., 1973; Gray et al., 1974; Woolf, 1974; Coggins, 1975; Hertzog, 1975; Pedersen and Thomas, 1975; Rapley and Mehren, 1975; Wentges, 1975; Wiesner, 1975; 1977; Farnsworth and Stowe, 1976; Haigh, 1976d; 1990b; 1991; 1993; Varland, 1976; Magonigle et al., 1977; Keep, 1979; Jarofke, 1980; Jessup et al., 1980; 1985b; Amstrup et al., 1982; Hebert et al., 1982; Thorne, 1982; Wiesner et al., 1982; 1984; Carpenter and Lance, 1983; Jones, 1984; Meulman et al., 1984; Silvestris and Heck, 1984; Stanley et al., 1984; 1988; 1989; Bailey et al., 1985; Olsen and Renecker, 1985; Rolfe and Haigh, 1985; Renecker and Olsen, 1986; Sedgwick, 1986; Haigh, 1987; Schobert, 1987; Williams and Riedesel, 1987; Franzmann and Lance, 1988; McCorquodale et al., 1988; Greene, 1988; Golightly and Hofstra, 1989; Jalanka and Roeken, 1990; Starke, 1991; Renecker et al., 1992; Haigh and Hudson, 1993; McJames et al., 1993; Smith et al., 1993; Pond and O'Gara, 1994; Millspaugh et al., 1995; Miller et al., 1996

ELK, ROOSEVELT, *Cervus elaphus roosevelti*

Weight: 265–284 (f), 318–499 (m) kg

Recommended Drug: 10 mg etorphine plus 20 mg acepromazine

Supplemental Drug: 5 mg etorphine

Antagonist: 2 mg diprenorphine per mg etorphine given

Alternative Drugs: 4 ml Large Animal Immobilon®

Comments: Roosevelt elk appear to require a higher dose of etorphine compared to North American elk (Hebert et al., 1982).

References: Harper, 1965; Thorne, 1982; Hebert et al., 1982; Carpenter and Lance, 1983

ELK, TULE, *Cervus elaphus nannodes*

Weight: 150–182 kg

Recommended Drug: 0.02 mg/kg carfentanil plus 0.24 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 min, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 4 mg etorphine plus 20 mg acepromazine, antagonize with 100 mg naltrexone or naloxone per mg carfentanil given

References: Alford et al., 1974; Hebert et al., 1982; Thorne, 1982; Carpenter and Lance, 1983; Greene, 1988

EMU, *Dromiceius novachollandie*

Weight: 40–55 kg

Recommended Drug: 22 mg/kg Telazol®

Supplemental Drug: 11 mg/kg ketamine

Antagonist: None

Alternative Drugs: 10 mg/kg ketamine plus 0.5 mg/kg xylazine

Comments: Xylazine use should be avoided in very sick birds. Also see Ostrich for additional comments

References: Beck, 1972; 1976; Schobert, 1987; Matthews, 1993; Jensen et al., 1994

ERMINE, *Mustela erminea*

Weight: 50–365 gm

Recommended Drug: 0.005 mg/gm ketamine plus 0.0001 mg/gm medetomidine

Supplemental Drug: 0.0025 mg/gm ketamine

Antagonist: 0.0005 mg/gm atipamezole; give 1/2 dose IV, 1/2 IM

Alternative Drugs: 0.03 mg/gm ketamine

References: Seal and Erickson, 1969; Seal et al., 1970; Genevois et al., 1984b; Seal and Kreeger, 1987; Jalanka and Roeken, 1990; Belant, 1992

ESEL - SEE ASS, WILD

FALCON, PEREGRINE, *Falco peregrinus*
Weight: 0.6–1.1 kg
Recommended Drug: 30 mg/kg ketamine plus 1.2 mg/kg diazepam, IV
Supplemental Drug: 5 mg/kg ketamine, IV
Antagonist: None
Alternative Drugs: 20 mg/kg ketamine
References: Borzio, 1973; Beck, 1976; Redig and Duke, 1976

FALCON, PRAIRIE, *Falco mexicanus*
Weight: 0.6–1.1 kg
Recommended Drug: 30 mg/kg ketamine plus 1.2 mg/kg diazepam, IV
Supplemental Drug: 5 mg/kg ketamine, IV
Antagonist: None
Alternative Drugs: 20 mg/kg ketamine
References: Borzio, 1973; Beck, 1976; Redig and Duke, 1976

FANALOKA - SEE FOSSA

FERRET, BLACK-FOOTED, *Mustela nigripes*
Weight: 0.7–1.5 kg
Recommended Drug: 3 mg/kg ketamine plus 0.075 mg/kg medetomidine
Supplemental Drug: 1.5 mg/kg ketamine
Antagonist: 0.45 mg/kg atipamezole
Alternative Drugs: 15 mg/kg ketamine plus 0.1 mg/kg diazepam
References: Thorne et al., 1985; Seal and Kreeger, 1987

FERRET, *Mustela putorius*
Weight: 0.6–1.2 kg
Recommended Drug: 25 mg/kg ketamine plus 2 mg/kg xylazine
Supplemental Drug: 12 mg/kg ketamine
Antagonist: None reported
Alternative Drugs: 25 mg/kg ketamine plus 1.1 mg/kg acepromazine
- 15 mg/kg Telazol®
- 5 mg/kg ketamine plus 0.1 mg/kg medetomidine

References: Seal et al., 1970; Beck, 1972; 1976; Boever et al., 1977; Carpenter and Hillman, 1978; Garver and Jackson, 1985; Moreland and Glaser, 1985; Schobert, 1987; Payton and Pick, 1989; Jalanka and Roeken, 1990; Marini et al., 1994

FISH, GENERAL
Recommended Drug: Tricaine methane sulfonate, 3–10 mg/100 ml water (0.003–0.01%)
Antagonist: Place fish in clean water (no anesthetic)
Comments: Use higher dose rates for *smaller* fish and lower dose rates for *larger* fish. The longer the fish is immersed in the anesthetic solution, the

longer the duration of effect.
References: McFarland and Klontz, 1969; Wedemeyer, 1970; Houston et al., 1971; Jolly et al., 1972; Stunkard and Miller, 1974; Sylvester, 1975; Smit et al., 1979; Smit and Hattingh, 1979; Genevois et al., 1983a; Cooper, 1984; Sedgwick, 1986; Harvey et al., 1988; Akhari and Dehghani, 1993; Brown, 1993; Malmstrom et al., 1993; Harms and Bakal, 1994

FISHER, *Martes pennanti*
Weight: 2.6–5.5 kg
Recommended Drug: 25 mg/kg ketamine plus 5 mg/kg xylazine
Supplemental Drug: 12 mg/kg ketamine
Antagonist: None reported
Alternative Drugs: 20 mg/kg ketamine plus 0.1 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970; Jessup et al., 1980; Jessup, 1982b; Seal and Kreeger, 1987; Belant, 1991

FOX, ARCTIC, *Alopex lagopus*
Weight: 2.5–9 kg
Recommended Drug: 2.5 mg/kg ketamine plus 0.05 mg/kg medetomidine
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: 0.125 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
• 10 mg/kg Telazol®
References: Heuschele, 1959; Seal and Erickson, 1969; Seal et al., 1970; Jalanka, 1987; Röken, 1987; Seal and Kreeger, 1987; Barnett and Lewis, 1990; Jalanka and Roeken, 1990

FOX, BAT-EARED, *Otocyon megalotis*
Weight: 3–5.3 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Alternative Drugs: 8 mg/kg ketamine and 0.5 mg/kg xylazine
• 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970; McKenzie and Burroughs, 1993

FOX, CAPE, *Vulpes chama*
Weight: 4 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Alternative Drugs: 8 mg/kg ketamine and 0.5 mg/kg xylazine
• 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
Comments: Use lightweight darts at low power settings.
References: McKenzie and Burroughs, 1993

FOX, CRAB-EATING, *Cerdocyon thous*
Weight: 6–7 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970

FOX, FENNEC, *Fennecus zerda*
Weight: 1–1.5 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970; Boever et al., 1977; Schobert, 1987

FOX, GRAY, *Urocyon cinereoargenteus*
Weight: 2.5–7 kg
Recommended Drug: 8.8 mg/kg Telazol®
Supplemental Drug: 8.8 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Kroll, 1962; Murry and Dennett, 1963; Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Brooks and Morris, 1979; Jessup et al., 1980; Jessup, 1982b; Hoilien and Oates, 1982; Schobert, 1987; Seal and Kreeger, 1987; Servin and Huxley, 1992

FOX, KIT, *Vulpes macrotis*
Weight: 3 kg
Recommended Drug: 10 mg/kg Telazol®
upplemental Drug: 10 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970; Jessup et al., 1980; Jessup, 1982b; Seal and Kreeger, 1987

FOX, RED, *Vulpes vulpes*
Weight: 4.1–4.5 (f), 4.5–5.4 (m) kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
- 20 mg/kg ketamine plus 1 mg/kg xylazine, antagonize with 0.15 mg/kg yohimbine
- 25 mg/kg ketamine plus 1 mg/kg midazolam

Comments: If using xylazine, wait at least 45 min after last ketamine injection before administering yohimbine.
References: Seal and Erickson, 1969; Göltenboth and Klös, 1970; Seal et al., 1970; Gray et al., 1974; Ramsden et al., 1976; Boever et al., 1977; Brooks and

Morris, 1979; Jessup et al., 1980; Jessup, 1982b; Hoilien and Oates, 1982; Genevois et al., 1984b; Wiesner and von Hegel, 1985; Schobert, 1987; Seal and Kreeger, 1987; Kreeger et al., 1989b; 1990a; 1990b; 1990c; Travaini et al., 1992; Travaini and Delibes, 1994

FOX, SOUTH AMERICAN, *Pseudalopex culpaeus*
Weight: 8–13 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970

FOX, SWIFT, *Vulpes velox*
Weight: 1.8–3 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970; Jessup et al., 1980; Jessup, 1982b; Seal and Kreeger, 1987

GALAGO, *Galago senegalensis*
Weight: 120–300 gm
Recommended Drug: 0.005 mg/gm Telazol®
Supplemental Drug: 0.005 mg/gm ketamine
Antagonist: None
Alternative Drugs: 0.015 mg/gm ketamine
References: Seal et al., 1970; Beck, 1972; 1976; Gray et al., 1974; Schobert, 1987

GALAGO, THICK-TAILED, *Otolemur crassicaudatus*
Weight: 0.6–2 kg
Recommended Drug: 8 mg/kg Telazol®
Supplemental Drug: 8 mg/kg ketamine
Antagonist: None
Comments: Also known as greater bush baby.
References: Kroll, 1962; Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Burroughs, 1993c

GAUR, *Bos gaurus*
Weight: 650–1,000 kg
Recommended Drug: 0.0074 mg/kg carfentanil plus 0.1 mg/kg xylazine
Supplemental Drug: 0.0074 mg/kg carfentanil
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.1 mg/kg yohimbine
Alternative Drugs: 2.5 ml Large Animal Immobilon® plus 100 mg xylazine;

antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 1 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

References: Bauditz, 1972; Rapley and Mehren, 1975; Wiesner, 1975; Wiesner et al., 1982; Conroy, 1986; Williams and Riedesel, 1987; Armstrong, 1981; Allen et al., 1991; Wilson, et al. 1993

GAZELLE, DAMA, *Gazella dama*

Weight: 20–60 kg

Recommended Drug: 0.035 mg/kg carfentanil

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given

Alternative Drugs: 0.4 ml Large Animal Immobilon® plus 2 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 2.4 mg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
- 4 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine (calm animals only)

Comments: Prone to excessive running during induction with carfentanil; monitor for hyperthermia.

References: Bauditz, 1972; Heck and Rivenburg, 1972; Röken, 1975; Jensen, 1982; Wiesner et al., 1982; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Wallace and Bush, 1987; Jacobson and Lukas, 1988; Allen et al., 1991; Schumacher et al., 1995

GAZELLE, DORCAS, *Gazella dorcas*

Weight: 20–60 kg

Recommended Drug: 0.035 mg/kg carfentanil

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given

Alternative Drugs: 0.1 ml Large Animal Immobilon® plus 2.5 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 10 mg/kg Telazol®
- 0.5 mg/kg fentanyl plus 1.56 mg/kg azaperone

Comments: Prone to excessive running during induction with carfentanil; monitor for hyperthermia.

References: Gray et al., 1974; Wiesner et al., 1982; Wiesner and von Hegel, 1985; Schobert, 1987; Greth et al., 1993

GAZELLE, GRANT'S, *Gazella granti*

Weight: 20–60 kg

Recommended Drug: 0.035 mg/kg carfentanil

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 10 mg/kg Telazol®
Comments: Prone to excessive running during induction with carfentanil; monitor for hyperthermia.
References: Talbot and Lamprey, 1961; Talbot and Talbot, 1962; Gray et al., 1974; Jensen, 1982; Schobert, 1987

GAZELLE, MOUNTAIN, *Gazella gazella*
Weight: 20 kg
Recommended Drug: 0.035 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 0.3 ml Large Animal Immobilon® plus 2 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 2.5 mg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
• 0.5 mg/kg fentanyl plus 1.56 mg/kg azaperone
Comments: Prone to excessive running during induction with carfentanil; monitor for hyperthermia.
References: Baharav and Tadmor, 1981; Wiesner et al., 1982; Furley, 1986; Greth et al., 1993; Rietjkerk et al., 1994

GAZELLE, PERSIAN, *Gazella subgutturosa*
Weight: 20–60 kg
Recommended Drug: 0.035 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 8.8 mg/kg Telazol®
• 0.5 mg/kg fentanyl plus 1.56 mg/kg azaperone
Comments: Prone to excessive running during induction with carfentanil; monitor for hyperthermia.
References: York and Huggins, 1972; Gray et al., 1974; Rapley and Mehren, 1975; Schobert, 1987; Allen et al., 1991; Greth et al., 1993

GAZELLE, SLENDER-HORNED, *Gazella leptoceros*
Weight: 20–60 kg
Recommended Drug: 0.035 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 10 mg/kg Telazol®
Comments: Prone to excessive running during induction with carfentanil; monitor for hyperthermia.
References: Gray et al., 1974; Schobert, 1987; Allen et al., 1991

GAZELLE, SOEMMERINGS, *Gazella soemmerringi*

Weight: 20–60 kg

Recommended Drug: 0.035 mg/kg carfentanil

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given

- 0.5 mg/kg fentanyl plus 1.56 mg/kg azaperone

Comments: Prone to excessive running during induction with carfentanil; monitor for hyperthermia.

References: Schobert, 1987; Greth et al., 1993

GAZELLE, THOMSON'S, *Gazella thomsonii*

Weight: 20–27 kg

Recommended Drug: 1.2 mg carfentanil (males); 1 mg carfentanil (females)

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given

Alternative Drugs: 1.5 mg etorphine plus 10 mg ketamine plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 8.8 mg/kg Telazol®
- 0.5 mg/kg fentanyl plus 1.56 mg/kg azaperone
- 3.6 mg/kg ketamine plus 4.6 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

Comments: Prone to excessive running during induction with carfentanil; monitor for hyperthermia.

References: Kroll, 1962; Talbot and Talbot, 1962; Bauditz, 1972; Jones, 1972; 1978; Gray et al., 1974; Haigh, 1976d; Schobert, 1987; Kock et al., 1989; Allen et al., 1991; Snyder et al., 1992; Greth et al., 1993

GEMSBOK, *Oryx gazella*

Weight: 150–240 kg

Recommended Drug: 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 0.03 mg/kg etorphine plus 0.25 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 3.5 mg etorphine plus 50 mg ketamine plus 50 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 2 mg/kg Telazol® plus 0.2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

Comments: Gemsbok are profoundly sensitive to xylazine; antagonism is essential. Semi-immobilized animals may show aggression towards humans; when immobilized restrain horns at all times.

References: Heuschele, 1961a; Ebedes, 1962; 1966b; 1967; 1969; 1975a;

Talbot and Talbot, 1962; Lanphear, 1963; Pienaar, 1968a; 1969b; 1973a; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; York and Huggins, 1972; Lyon and Dinning, 1973; Smuts, 1973; Young and Whyte, 1973; Gray et al., 1974; De Vos, 1975; Hertzog, 1975; Rapley and Mehren, 1975; Röken, 1975; Haigh, 1976d; De Vos 1978; Jessup et al., 1980; Hofmeyr, 1981; Jensen, 1982; Wiesner et al., 1982; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Sedgwick, 1986; Schobert, 1987; Kock et al., 1989; Allen et al., 1991; Berry, 1992; IWVS, 1992; Snyder et al., 1992; Majonica and Bonath, 1993; Burroughs, 1993d

GENET, *Genetta spp.*
Weight: 1–3 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 30 mg/kg ketamine plus 0.3 mg/kg acepromazine
• 7 mg/kg ketamine plus 10 mg/kg xylazine
References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Genevois et al., 1984b; Schobert, 1987; Maddock, 1989; Fuller et al., 1990; McKenzie and Burroughs, 1993; Palomares, 1993

GERBILS, GENERAL
Weight: 30–200 gm
Recommended Drug: 0.044 mg/gm ketamine plus 0.006 mg/gm xylazine
Supplemental Drug: 0.022 mg/gm ketamine
Antagonist: None reported
Alternative Drugs: 0.05 mg/gm ketamine plus 0.002 mg/gm xylazine
• 0.05 mg/gm ketamine plus 0.005 mg/gm diazepam
• 0.075 mg/gm ketamine plus 0.003 mg/gm acepromazine
• 0.005 mg/gm Telazol®
References: Beck, 1976; Lightfoote and Molinari, 1978; Flecknell et al., 1983; Genevois et al., 1984a; Garver and Jackson, 1985

GIBBON, SIAMANG, *Hylobates syndactylus*
Weight: 8–13 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
References: Kroll, 1962; Gray et al., 1974; Bush et al., 1977; Schobert, 1987

GIBBON, WHITE-CHEEKED (CRESTED), *Hylobates concolor*
Weight: 4–8 kg
Recommended Drug: 3.3 mg/kg Telazol®
Supplemental Drug: 3.3 mg/kg ketamine
Antagonist: None

Alternative Drugs: 16 mg/kg ketamine
References: Gray et al., 1974; Bush et al., 1977; Schobert, 1987

GIBBON, WHITE-HANDED (LAR), *Hylobates lar*
Weight: 4–8 kg
Recommended Drug: 3 mg/kg ketamine plus 0.07 mg/kg medetomidine
Supplemental Drug: 1.5 mg/kg ketamine
Antagonist: 0.35 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 4.4 mg/kg Telazol®
• 12 mg/kg ketamine
References: Kroll, 1962; Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; 1976; Beck and Dresner, 1972; Jessup et al., 1980; Schobert, 1987; Jalanka and Roeken, 1990; Mortenson, 1994

GIRAFFE, *Giraffa camelopardalis*
Weight: 550–1,800 kg
Recommended Drug: 8 mg carfentanil plus 100 mg xylazine plus 10 mg atropine
Supplemental Drug: 3 mg carfentanil
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.05 mg/kg yohimbine
Alternative Drugs: 4.5 mg etorphine plus 70 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.05 mg/kg yohimbine
• 11 mg etorphine (bull), 9 mg etorphine (cow), 6 mg etorphine (young)
• 8 mg/kg Telazol®
Comments: Immobilization mortality can be as high as 35% in giraffes. The current capture philosophy for giraffes is to dose high and *quickly antagonize* after physical restraint has been achieved. If possible, a physical restraining device should be used in preference to, or in conjunction with, chemical immobilization. Do not attempt immobilization without expert consultation and thorough familiarity with the literature (e.g., Morkel, 1993b). Preferably, work with someone with experience. Blood pressure must be maintained in order to perfuse the brain. Opioids cause profound respiratory depression. Capture must not be attempted if ambient temperature is >25° C (77° F). Hyaluronidase (2,000 IU) can be added to the drug mixture to increase absorption. Geisler et al. (1992) successfully immobilized a one-month-old giraffe (129 kg) with 1.5 mg etorphine plus 30 mg xylazine, total dose.
References: Goetz, 1955; Buechner et al., 1960a; 1960c; Harthoorn, 1960; 1963a; 1965a; 1973a; 1973b; Harthoorn and Lock, 1961; Talbot and Lamprey, 1961; Talbot and Talbot, 1962; Larsen, 1963; Van Niekerk et al., 1963a; Van Niekerk and Pienaar, 1963a; 1969a; Pienaar and Fairall, 1963; Wright, 1963; Graham-Jones, 1964; Harthoorn and Bligh, 1965; Hirst et al., 1965; Hirst, 1966; Pienaar et al., 1966a; Wallach et al., 1967; Wallach, 1968; 1969; Williamson and Wallach, 1968; 1969; Sedgwick and Acosta, 1969; York and Kidder, 1971; Harthoorn, 1972a; Jones, 1972; Langman, 1973; Alford et al.,

1974; De Vos, 1975; Hertzog, 1975; Mehren and Rapley, 1975; Rapley and Mehren, 1975; Röken, 1975; York, 1975; Bush, 1976; Bush et al., 1976; 1980; Haigh, 1976d; Wiesner et al., 1982; Citino et al., 1984; Meltzer et al., 1985; Savage, 1985; Hugues et al., 1986; Sedgwick, 1986; Bush and De Vos, 1987; Calle and Bornmann, 1988; Wiesner and von Hegel, 1989; Geiser et al., 1992; Morkel, 1992b; IWVS, 1992; Morkel, 1993b

GLIDER, SUGAR, *Petaruus breviceps*
Weight: 90–130 gm
Recommended Drug: 0.011 mg/gm Telazol®
Supplemental Drug: 0.01 mg/gm ketamine
Antagonist: None
Comments: Caution: Holz (1992) reported 100% mortality ($n = 3$) in squirrel gliders (*Petaurus norfolcensis*) given 10 mg/kg Telazol®.
References: Bush et al., 1990; Holz, 1992

GNU - SEE WILDEBEEST

GOAT, FERAL, *Capra hircus*
Weight: 20–80 kg
Recommended Drug: 15 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 20 mg/kg ketamine
• 0.028 mg/kg etorphine; antagonize with 0.056 mg/kg diprenorphine
References: Jarvis and Morris, 1960; Gauckler and Kraus, 1970; Rudge and Joblin, 1976; Jessup et al., 1980; Merilan, 1986; Schobert, 1987; Sleeman and Ramsay, 1995

GOAT, MOUNTAIN, *Oreamnos americanus*
Weight: 46–140 kg
Recommended Drug: 1.5 mg/kg ketamine plus 0.07 mg/kg medetomidine
upplemental Drug: 1 mg/kg ketamine
Antagonist: 0.35 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 4 mg etorphine plus 30 mg xylazine antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
• 2.75 mg carfentanil; antagonize with 100 mg naloxone or naltrexone per mg carfentanil given
References: Hebert and Cowan, 1971; McKean and Magonigle, 1978; Jessup et al., 1980; Thorne, 1982; Carpenter and Lance, 1983

GOOSE, CANADA, *Branta canadensis*
Weight: 3.3–3.8 kg
Recommended Drug: 20 mg/kg Telazol®
Supplemental Drug: 20 mg/kg ketamine

Antagonist: None
References: Crider and McDaniel, 1966; 1967; 1968; Crider et al., 1968; Krapu, 1976

GOOSE, EGYPTIAN, *Alopechen aegyptiacus*
Weight: 1.2–1.5 kg
Recommended Drug: 22 mg/kg Telazol®
Supplemental Drug: 22 mg/kg ketamine
Antagonist: None
References: Schobert, 1987

GOOSE, LESSER MAGELLAN, *Chlorphaga picta*
Weight: 2.7–3.2 kg
Recommended Drug: 8.8 mg/kg Telazol®
Supplemental Drug: 8.8 mg/kg ketamine
Antagonist: None
References: Schobert, 1987

GOOSE, WHITE-FRONTED, *Anserini albiforns frontalis*
Weight: 1.3–2.3 kg
Recommended Drug: 2.7 mg/kg Telazol®
Supplemental Drug: 2.7 mg/kg ketamine
Antagonist: None
References: Schobert, 1987

GORILLA, *Gorilla gorilla*
Weight: 70–140 (f), 135–275 (m) kg
Recommended Drug: 5 mg/kg ketamine plus 0.05 mg/kg medetomidine
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: 0.25 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 2.2 mg/kg Telazol®
• 15 mg/kg ketamine
References: Jarvis and Morris, 1960; Marsboom et al., 1962; 1963; Seal et al., 1970a; 1970b; Beck, 1972; Bush et al., 1971; 1977; Beck and Dresner, 1972; Gray et al., 1974; Vercruysse and Mortelmans, 1978; Jessup et al., 1980; Ludders et al., 1982; Cook and Clarke, 1984; 1985; Hess and Knakal, 1985; Robinson and Lambert, 1986; Schobert, 1987; Jalanka and Roeken, 1990

GOSHAWK, *Accipiter gentilis*
Weight: 0.9–1.5 kg
Recommended Drug: 20 mg/kg ketamine
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
References: Borzio, 1973; Beck, 1976; Lumeij, 1986

GRIVET, *Cercopithecus aethiops*
Weight: 5–9 kg
Recommended Drug: 8.8 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 12 mg/kg ketamine
References: Beck, 1976; Schobert, 1987

GRYSBOK, *Raphicerus melanotis*
Weight: 7–16 kg
Recommended Drug: 5 mg fentanyl plus 10 mg azaperone
Supplemental Drug: 2.5 mg/kg fentanyl
Antagonist: 0.2 mg/kg naloxone
Alternative Drugs: 8 mg/kg Telazol®
Comments: Monitor for respiratory depression when using opioids.
References: Burroughs, 1993d

GRYSBOK, SHARPE'S, *Raphicerus sharpei*
Weight: 7–16 kg
Recommended Drug: 5 mg fentanyl plus 10 mg azaperone
Supplemental Drug: 2.5 mg/kg fentanyl
Antagonist: 0.2 mg/kg naloxone
Alternative Drugs: 8 mg/kg Telazol®
Comments: Monitor for respiratory depression when using opioids.
References: Burroughs, 1993d

GUANACO, *Lama guanicoe*
Weight: 100–120 kg
Recommended Drug: 2 mg/kg ketamine plus 0.1 mg/kg medetomidine
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 0.5 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 6 mg/kg Telazol®
• 3.25 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
Comments: Jones (1977a) stated that the use of opioids in llama was contraindicated; assume the same for guanaco.
References: Larsen, 1963; Bauditz, 1972; Beck, 1972; Jones, 1972; Hertzog, 1975; Haigh, 1976d; Rapley and Mehren, 1975; De Lamo and Garrido, 1983; Wiesner and von Hegel, 1985; Kock et al., 1989; Jalanka and Roeken, 1990; Sarno et al., 1996

GUENONS - ALSO SEE MONKEY (GUENON)

GUENON, LESSER WHITE-NOSED, *Cercopithecus petaurista*
Weight: 4–8 kg
Recommended Drug: 2 mg/kg Telazol®

Supplemental Drug: 2 mg/kg ketamine
Antagonist: None
References: Schobert, 1987

GUENON, WHITE-NOSED, *Cercopithecus nictitans*
Weight: 2–8 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
References: Schobert, 1987

GUINEA PIG, *Cavia spp.*
Weight: 0.5–1.5 kg
Recommended Drug: 40 mg/kg ketamine plus 5 mg/kg xylazine
upplemental Drug: 20 mg/kg ketamine
Antagonist: None
Alternative Drugs: 40 mg/kg ketamine plus 2 mg/kg acepromazine
• 50 mg/kg Telazol®
References: Love, 1970; Rubright and Thayer, 1970; Weisbroth and Fudens, 1972; Stunkard and Miller, 1974; Hughes et al., 1975; Mulder et al., 1979; Gilroy and Varga, 1980; Genevois et al., 1984a; Garver and Jackson, 1985

GUINEAFOWL, *Numida meleagris*
Weight: 3–5 kg
Recommended Drug: 25 mg/kg ketamine plus 1 mg/kg xylazine
Supplemental Drug: 12.5 mg/kg ketamine
Antagonist: 0.15 mg/kg yohimbine
References: Teare, 1987

GYRFALCON, *Falco rusticolus*
Weight: 1.4–1.6 kg
Recommended Drug: 20 mg/kg ketamine plus 1.2 mg/kg diazepam, IV
Supplemental Drug: 5 mg/kg ketamine, IV
Antagonist: None
Alternative Drugs: 20 mg/kg ketamine
References: Borzio, 1973; Beck, 1976; Redig and Duke, 1976

HAMSTERS, GENERAL
Weight: 112–908 gm
Recommended Drug: 0.044 mg/gm ketamine plus 0.006 mg/gm xylazine
Supplemental Drug: 0.022 mg/gm ketamine
Antagonist: None reported
Alternative Drugs: 0.01 mg/gm Telazol®
References: Hughes et al., 1975; Mulder et al., 1979; Genevois et al., 1984a; Garver and Jackson, 1985; Forsyth et al., 1992

HARTEBEEST, *Alcelaphus buselaphus*

Weight: 140–170 kg

Recommended Drug: 4 mg etorphine plus 20 mg xylazine

Supplemental Drug: 2 mg etorphine

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Comments: Difficult to immobilize, often struggle against recumbency and continue to run.

References: Buechner et al., 1960a; 1960c; Lanphear, 1963; Bigalke, 1965; Pienaar et al., 1966a; Pienaar, 1969b; 1973a; Harthoorn, 1971; Bartmann, 1972; Bauditz, 1972; Heck and Rivenburg, 1972; Kok, 1973; Hirst et al., 1965; De Vos, 1975; Röken, 1975; Grootenhuis et al., 1976; Haigh, 1976d; Slee and Walker, 1977; Hofmeyr, 1981; Kupper et al., 1981; Jensen, 1982; Berry, 1992; IWVS, 1992; Burroughs, 1993d

HAWK, BROAD-WINGED, *Buteo platypterus*

Weight: 0.3–0.5 kg

Recommended Drug: 45 mg/kg ketamine plus 1.25 mg/kg diazepam, IV

Supplemental Drug: 5 mg/kg ketamine, IV

Antagonist: None

lternative Drugs: 20 mg/kg ketamine plus 2 mg/kg acepromazine

References: Mattingly, 1972; Redig and Duke, 1976; Freed and Baker, 1980; 1989; Jessup et al., 1980

HAWK, RED-SHOULDERED, *Buteo lineatus*

Weight: 0.5–1.3 kg

Recommended Drug: 20 mg/kg ketamine plus 2 mg/kg acepromazine

Supplemental Drug: 10 mg/kg ketamine

Antagonist: None

Alternative Drugs: 15 mg/kg Telazol®

References: Jessup et al., 1980

HAWK, RED-TAILED, *Buteo jamaicensis*

Weight: 0.6–1.4 kg

Recommended Drug: 4.4 mg/kg ketamine plus 2.2 mg/kg xylazine

Supplemental Drug: 2.2 mg/kg ketamine

Antagonist: 0.1 mg/kg yohimbine

Alternative Drugs: 35 mg/kg ketamine plus 1.5 mg/kg diazepam, IV

- 10 mg/kg ketamine plus 2 mg/kg xylazine
- 20 mg/kg ketamine plus 2 mg/kg acepromazine

Comments: Telazol® in these hawks caused copious salivation and less than satisfactory immobilization (Kreeger et al., 1993).

References: Kittle, 1972; Mattingly, 1972; Borzio, 1973; Frank and Cooper, 1974; Haupert and Lindeen, 1974; Cooper and Redig, 1975; Beck, 1976; Redig and Duke, 1976; Kollias and McLeish, 1978; Freed and Baker, 1980; 1989; Jessup et al., 1980; Degernes et al., 1988; Fitzgerald, 1993; Kreeger et al., 1993

HAWK, ROUGH-LEGGED, *Buteo lagopus*
Weight: 700 gm
Recommended Drug: 0.03 mg/gm ketamine plus 0.0012 mg/gm diazepam IV
Supplemental Drug: 0.005 mg/gm ketamine IV
Antagonist: None
Alternative Drugs: 0.02 mg/gm ketamine plus 0.002 mg/gm acepromazine
References: Redig and Duke, 1976

HAWKS, GENERAL
Recommended Drug: 30 mg/kg ketamine plus 1.5 mg/kg diazepam, IV
Supplemental Drug: 5 mg/kg ketamine, IV
Antagonist: None
Alternative Drugs: 20 mg/kg ketamine plus 2 mg/kg acepromazine
• 15 mg/kg Telazol®
Comments: Telazol® in some hawks may cause copious salivation and less than satisfactory immobilization.
References: Redig and Duke, 1976; Jessup et al., 1980; Amand, 1982a

HEDGEHOG, *Erinaceus europaeus*
Weight: 0.4–1.1 kg
Recommended Drug: 2 mg/kg ketamine plus 0.2 mg/kg medetomidine plus 0.1 mg/kg fentanyl
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 1 mg/kg atipamezole plus 0.16 mg/kg naloxone
Alternative Drugs: 5 mg/kg ketamine plus 0.2 mg/kg medetomidine; antagonize with 1 mg/kg atipamezole
• 5 mg/kg Telazol®
Comments: Expect prolonged recoveries with Telazol®.
References: Seal and Erickson, 1969; Seal et al., 1970; Schobert, 1987; Jalanka and Roeken, 1990; Arnemo and Søli, 1995

HERON, GREEN, *Butorides virescens*
Weight: 100 gm
Recommended Drug: 0.075 mg/gm Telazol®
Supplemental Drug: 0.075 mg/kg ketamine
Antagonist: None
References: Kittle, 1972; Schobert, 1987

HIPPOPOTAMUS, *Hippopotamus amphibius*

Weight: 1,000–4,500 kg

Recommended Drug: 0.7 ml Large Animal Immobilon® plus 8 mg xylazine

Supplemental Drug: 0.35 ml Large Animal Immobilon®

Antagonist: 3.5 mg diprenorphine or 85 mg naloxone

Alternative Drugs: 2.5 mg etorphine (bull); 2 mg etorphine (cow); antagonize with 2.4 mg diprenorphine per mg etorphine given

- 2 mg etorphine plus 200 mg azaperone plus 250 mg succinylcholine

Comments: Hippos are very difficult to chemically immobilize; physical restraint is preferred. Estimate drug doses carefully; etorphine is not tolerated well by hippos, respiratory arrest can occur even at low doses - minimize immobilization time if at all possible (preferably less than 30 min.). Etorphine and acepromazine mixtures and fentanyl and azaperone mixtures have caused side effects such as sweating, salivation, and muscular hypertonicity. Use long darts (≥ 80 mm).

References: Buechner et al., 1960c; 1960d; Harthoorn, 1960; 1963d; 1965a; 1972a; 1973a; 1973b; Harthoorn and Lock, 1961; Buck et al., 1963; Van Niekerk et al., 1963a; 1963b; Van Niekerk and Pienaar, 1963a; Pienaar et al., 1966a; Pienaar, 1967a; 1969a; 1969b; Jones, 1972; York and Huggins, 1972; York, 1973b; Alford et al., 1974; Haigh, 1976d; Reed, 1978; Stoskopf and Bishop, 1978; Wiesner et al., 1982; Pearce et al., 1985; Wiesner and von Hegel, 1985; Sedgwick, 1986; IWVS, 1992

HIPPOPOTAMUS, PYGMY, *Choeropsis liberiensis*

Weight: 160–270 kg

Recommended Drug: 2.5 mg etorphine plus 125 mg xylazine

Supplemental Drug: 1.5 mg etorphine

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 0.25 ml Large Animal Immobilon®; antagonize with 2 mg diprenorphine per mg etorphine given

Comments: See comments on Hippopotamus above.

References: Jones, 1972; Wiesner et al., 1982; Pearce et al., 1985

HOG, EUROPEAN WILD, *Sus scrofa*

Weight: 100–350 kg

Recommended Drug: 10 mg/kg ketamine plus 0.2 mg/kg acepromazine

Supplemental Drug: 5 mg/kg ketamine

Antagonist: None

Alternative Drugs: 10 mg/kg ketamine plus 0.5 mg/kg xylazine

- 4 mg/kg Telazol® plus 2 mg/kg xylazine
- 0.022 mg/kg etorphine plus 0.11 mg/kg acepromazine; antagonize with 2 mg diprenorphine per mg etorphine given
- 1.2 ml Large Animal Immobilon® plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given

Comments: Hogs can overheat readily, particulary when using etorphine or xylazine.
References: Zurowski and Sakowicz, 1965; Austin and Peoples, 1967; Henry and Matschke, 1968; 1972; Matschke and Henry, 1969a; 1969b; Seal et al., 1970; Vertessen, 1970; Jones, 1972; Alford et al., 1974; Wood et al., 1977; Jessup et al., 1980; Baber and Coblentz, 1982; Wiesner et al., 1982; Wiesner and von Hegel, 1985; Macek, 1987; Strauss, 1987; Bonath et al., 1992; Siemon et al., 1992

HORSE, PRZEWALSKI, *Equus caballus*
Weight: 275–455 kg
Recommended Drug: 2 mg/kg ketamine plus 0.08 mg/kg medetomidine
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 0.4 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.02 mg/kg carfentanil; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given
• 0.02 mg/kg etorphine plus 0.2 mg/kg xylazine plus 0.08 mg/kg acepromazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: These horses are difficult animals to immobilize. No ideal drug combination has yet been determined. Be prepared for ataxia and especially hyperthermia. Have cooling water available. Muscle relaxation is notoriously poor, even when midazolam/diazepam is employed. It is also recommended to give equal doses of the opioid antagonists both IV and IM to reduce renarcotization.
References: Larsen, 1963; Bauditz, 1972; Heck and Rivenburg, 1972; Alford et al., 1974; Jones, 1976; 1978; Oosterhuis, 1979; Wright, 1981; Wiesner et al., 1982; Janssen and Oosterhuis, 1984; Kock and Pearce, 1985; Wiesner and von Hegel, 1985; Kuttner and Wiesner, 1987; Jalanka and Roeken, 1990; Allen, 1990a; 1992a; Morris, 1992; Wiesner, 1993; Matthews et al., 1995

HORSE, NORTH AMERICAN WILD, *Equus caballus*
Weight: 250–530 kg
Recommended Drug: 0.02 mg/kg carfentanil plus 0.6 mg/kg xylazine
Supplemental Drug: If animal is not down in 20 min, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 5.5 mg etorphine plus 1,300 mg xylazine plus 7.5 mg atropine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.1 mg/kg yohimbine
Comments: Yohimbine must be administered to horses receiving xylazine.
References: Alford et al., 1974; Jones, 1978; Borchard, 1980; Jessup et al., 1980; 1985b; Berger et al., 1983; Seal et al., 1985a; Plotka et al., 1987; Matthews and Meyers, 1993

HUTIA, HISPANOLIA, *Plagiodontia aedium*

Weight: 1–1.3 kg

Recommended Drug: 6.6 mg/kg Telazol®

Supplemental Drug: 6.6 mg/kg ketamine

Antagonist: None

References: Schobert, 1987

HYENA, BROWN, *Hyaena brunnea*

Weight: 37–47.5 kg

Recommended Drug: 5 mg/kg Telazol®

Supplemental Drug: 2 mg/kg ketamine

Antagonist: None

Alternative Drugs: 10 mg/kg ketamine plus 1 mg/kg xylazine; antagonize with 0.11 mg/kg yohimbine

Comments: The long coat of the brown hyena may lead to overestimation of weight and interfere with accurate dart placement.

References: Seal and Erickson, 1969; Seal et al., 1970; Ebedes, 1973b; Wiesner, 1977; Wiesner and von Hegel, 1985; McKenzie and Burroughs, 1993

HYENA, SPOTTED, *Crocuta crocuta*

Weight: 40–86 kg

Recommended Drug: 5 mg/kg Telazol®

Supplemental Drug: 2 mg/kg ketamine

Antagonist: None

Alternative Drugs: 10 mg/kg ketamine plus 1 mg/kg xylazine; antagonize with 0.11 mg/kg yohimbine

• 0.05 mg/kg etorphine plus 0.6 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine

Comments: Respiratory depression can occur when etorphine and xylazine are used.

References: Heuschele, 1961a; Kroll, 1962; Talbot and Talbot, 1962; Ericksen, 1968; Seal and Erickson, 1969; Pienaar et al., 1969; Seal et al., 1970; Ebedes, 1973b; Smuts, 1973b; Young and Whyte, 1973; Gray et al., 1974; Beck, 1976; Whately, 1979; Genevois et al., 1984b; Schobert, 1987; Van Jaarsveld, 1988; Stander and Gasawy, 1991; IWVS, 1992; Van Jaarsveld and Skinner, 1992; McKenzie and Burroughs, 1993

HYENA, STRIPED, *Hyaena hyaena*

Weight: 25–55 kg

Recommended Drug: 5 mg/kg Telazol®

Supplemental Drug: 2 mg/kg ketamine

Antagonist: None

Alternative Drugs: 10 mg/kg ketamine plus 1 mg/kg xylazine; antagonize with 0.11 mg/kg yohimbine

References: Larsen, 1963; Seal and Erickson, 1969; Göltenboth and Klös,

1970; Seal et al., 1970; Bauditz, 1972; Nair, 1977; Genevois et al., 1984b

IBEX, ALPINE, *Capra ibex*

Weight: 35–150 kg

Recommended Drug: 0.004 mg/kg carfentanil plus 0.015 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 1.5 mg/kg ketamine plus 0.11 mg/kg medetomidine; antagonize with 0.5 mg/kg atipamezole

- 2 mg etorphine plus 20 mg ketamine plus 20 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
- 0.8 ml Large Animal Immobilon® plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 0.05 mg/kg fentanyl plus 0.5 mg/kg xylazine; antagonize with 0.2 mg/kg naloxone plus 0.125 mg/kg yohimbine

Comments: Monitor for hyperthermia and respiratory depression.

References: Boch et al., 1961; Gauckler and Kraus, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; Mehren and Rapley, 1975; Rapley and Mehren, 1975; Wentges, 1975; Jensen, 1982; Wiesner et al., 1982; 1984; Duchamps, 1985; De Meneghi et al., 1987; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Allen et al., 1991; Snyder et al., 1992; Escos and alados, 1993

IGUANA, *Iguana iguana*

Weight: 0.5–1.5 kg

Recommended Drug: 10 mg/kg Telazol®

Supplemental Drug: 10 mg/kg ketamine

Antagonist: None

Alternative Drugs: 35 mg/kg ketamine

References: Cooper, 1971; Beck, 1972; 1976; Gray et al., 1974; Jessup et al., 1980; Schobert, 1987

IMPALA, *Aepyceros melampus*

Weight: 45–60 kg

Recommended Drug: 0.006 mg/kg carfentanil plus 0.15 mg/kg xylazine

Supplemental Drug: 0.003 mg/g carfentanil

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 1 mg etorphine plus 15 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine

- 4.85 mg/kg Telazol®
- 12 mg fentanyl plus 3 mg xylazine

Comments: Monitor for respiratory depression when opioids are used. Impala are small, so accurate dart placement is critical to avoid injury. Impala often move into brush after being struck, making location difficult.

References: Talbot and Lamprey, 1961; Kroll, 1962; Van Niekerk et al., 1963a; 1963b; Van Niekerk and Pienaar, 1963a; Pienaar and Fairall, 1963; Graham-Jones, 1964; Harthoorn and Bligh, 1965; Hirst et al., 1965; Pienaar et al., 1966a; Ables, 1969; Pienaar, 1968a; 1969b; 1973a; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; 1978; York and Huggins, 1972; Hofmeyr and de Bruine, 1973; Smuts, 1973a; Smuts et al., 1973; Young and Whyte, 1973; Drevemo and Harstad, 1974; De Vos, 1975; Röken, 1975; York, 1975; Grootenhuis et al., 1976; Haigh, 1976d; Murray et al., 1971; Hofmeyr, 1981; Wiesner et al., 1982; 1984; 1985; Wiesner and von Hegel, 1985; Schobert, 1987; Williams and Riedesel, 1987; Cheney and Hattingh, 1988; Gandini et al., 1989; Raath and Knox, 1989; Knox et al., 1990; Allen et al., 1991; Knox, et al., 1991; Janssen et al., 1991; IWVS, 1992; Janssen et al., 1993; Burroughs, 1993d

JACKAL, BLACK-BACKED, *Canis mesomelas*
Weight: 7–13.5 kg
Recommended Drug: 8 mg/kg Telazol®
Supplemental Drug: 8 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Young, 1966; Rowe-Rowe and Green, 1980; IWVS, 1992; McKenzie and Burroughs, 1993

JACKAL, GOLDEN, *Canis aureus*
Weight: 7–15 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
• 8 mg/kg ketamine plus 0.5 mg/kg xylazine
References: Seal and Erickson, 1969; Seal et al., 1970; Genevois et al., 1984b

JACKAL, SIDE STRIPED, *Canis adustus*
Weight: 6.5–14 kg
Recommended Drug: 8 mg/kg Telazol®
Supplemental Drug: 8 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
• 8 mg/kg ketamine plus 0.5 mg/kg xylazine
References: IWVS, 1992; McKenzie and Burroughs, 1993

JACKAL, SIMIEN, *Canis simensis*
Weight: 10–18 kg
Recommended Drug: 4 mg/kg Telazol®
Supplemental Drug: 4 mg/kg ketamine
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Boever et al., 1977; Sillero-Zubiri, 1996

JAGUAR, *Panthera onca*
Weight: 64–114 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2 mg/kg ketamine
Antagonist: None
Alternative Drugs: 2.5 mg/kg ketamine plus 0.07 mg/kg medetomidine
• 4 mg/kg ketamine plus 2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
References: Larsen, 1963; Seal and Erickson, 1969; Seal et al., 1970; Bauditz, 1972; Gray et al., 1974; Hime, 1974; Beck, 1976; Boever et al., 1977; Wiesner, 1977; Genevois et al., 1984b; Arora et al., 1983; Wiesner and von Hegel, 1985; Gonzales and McDonnel, 1986; Göltenboth and Klös, 1987; Schobert, 1987; Seal and Kreeger, 1987; Kock et al., 1989; Barnett and Lewis, 1990; Jalanka and Roeken, 1990

JAGUARUNDI, *Felis yagouaroundi*
Weight: 4.5–9 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 3.3 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 1 mg/kg xylazine
References: Dyson, 1965; Seal and Erickson, 1969; Seal et al., 1970; Genevois et al., 1984b; Gray et al., 1974; Schobert, 1987; Seal and Kreeger, 1987

JAVELINA - SEE PECCARY

KANGAROO, BENNETT'S TREE, *Dendrolagus bennettianus*
Weight: 6.7–10 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
References: Shima et al., 1993

KANGAROO, EASTERN GREY, *Macropus giganteus*
Weight: 30–55 kg
Recommended Drug: 6 mg/kg Telazol®
Supplemental Drug: 3 mg/kg ketamine
Antagonist: None
Alternative Drugs: 9 mg/kg ketamine
References: Larsen, 1963; Wellington, 1972; Denny, 1974; Finnie, 1976; Bush et al., 1990; Shima et al., 1993

KANGAROO, RED, *Macropus rufus*
Weight: 20–40 kg

Recommended Drug: 7 mg/kg Telazol®
Supplemental Drug: 3.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 8 mg/kg ketamine plus 8 mg/kg xylazine
Comments: Immobilon® has been shown to be unsatisfactory for this species.
References: Heuschele, 1961; Larsen, 1963; Seal and Erickson, 1969; Seal et al., 1970; Denny, 1973; 1974; Wilson, 1974; 1976; Beck, 1976; Finnie, 1976; 1986; Wilson, 1976; Boever et al., 1977; Smeller et al., 1977; Wiesner, 1977; Wiesner and von Hegel, 1985; Schobert, 1987; Bush et al., 1990; Shima et al., 1993

KANGAROO, TREE, *Dendrolagus matschiei*
Weight: 6.7–10 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 5 mg/kg ketamine
Comments: Sometimes referred to as Goodfellows' tree kangaroo
References: Smeller et al., 1977; Schobert, 1987; Bush et al., 1990; Shima et al., 1993

KANGAROO, WESTERN GREY, *Macropus fuliginosus*
Weight: 30–50 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
References: Watson and Way, 1973; Denny, 1974; Finnie, 1976; Arnold et al., 1986; Bush et al., 1990

KESTREL, AMERICAN, *Falco sparverius*
Weight: 0.1–0.12 kg
Recommended Drug: 5 mg/kg ketamine plus 2.2 mg/kg diazepam, IV
Supplemental Drug: 5 mg/kg ketamine, IV
Antagonist: None
References: Redig and Duke, 1976; Camburn and Stead, 1978; Freed and Baker, 1989

KINKAJOU, *Potus flavus*
Weight: 1.4–4.6 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 25 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Beck, 1976; Gray et al., 1974; Genevois et al., 1984b; Hugues et al., 1986; Schobert, 1987

KLIPSPRINGER, *Oreotragus oreotragus*

Weight: 8–18 kg

Recommended Drug: 0.01 mg/kg etorphine plus 0.4 mg/kg xylazine

Supplemental Drug: 0.005 mg/kg etorphine

Antagonist: 2 mg/kg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine

Alternative Drugs: 0.2 mg/kg fentanyl plus 0.4 mg/kg xylazine

• 2.1 mg/kg ketamine plus 0.16 mg/kg medetomidine; antagonize with 0.8 mg/kg atipamezole

Comments: Monitor for respiratory depression when using opioids.

References: IWVS, 1992

KOALA, *Phascolarctos cinereus*

Weight: 8.2–10.4 kg

Recommended Drug: 7 mg/kg Telazol®

Supplemental Drug: 3.5 mg/kg ketamine

Antagonist: None

Alternative Drugs: 16 mg/kg ketamine plus 0.6 mg/kg xylazine

References: Robinson, 1981; Bush et al., 1990; Holz, 1992; Shima et al., 1993

KOB, UGANDA, *Kobus kob*

Weight: 100–300 kg

Recommended Drug: 2.1 mg carfentanil (males); 1.5 mg carfentanil (females); plus 5 mg xylazine (both sexes)

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 5 mg/kg Telazol®

• 1 mg etorphine plus 80 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

• 1 ml Large Animal Immobilon®; antagonize with 2 mg diprenorphine per mg etorphine given

• 1 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

References: Buechner et al., 1960a; 1960b; 1960c; 1960d; Harthoorn, 1960; Talbot and Lamprey, 1961; Bauditz, 1972; Röken, 1975; Küpper et al., 1981; Hugues et al., 1986; Wanzie, 1986; Okaeme et al., 1988; Allen et al., 1991

KUDU, *Tragelaphus strepsiceros*

Weight: 160–250 kg

Recommended Drug: 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 8 mg etorphine plus 50 mg xylazine; antagonize with 2 mg

diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 2.5 mg carfentanil plus 40 mg ketamine plus 40 mg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
• 1.4 ml Large Animal Immobilon® plus 5 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 3 mg etorphine plus 150 mg ketamine plus 150 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 6 mg/kg Telazol®

Comments: Prone to excessive running during induction with opioids; monitor for hyperthermia. A muscle relaxant (xylazine, etc.) is essential to prevent capture myopathy. Hyaluronidase may be added to the drug mixture to hasten induction.

References: Heuschele, 1959; Lanphear, 1963; Bigalke, 1965; Harthoorn and Bligh, 1965; Pienaar et al., 1966a; Pienaar, 1969b; 1973a; Wallach et al., 1967; Hime and Jones, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; 1978; York and Huggins, 1972; Smuts, 1973; 1975; Young and Whyte, 1973; De Vos, 1975; Röken, 1975; Wiesner, 1975; York, 1975; Haigh, 1976d; Hofmeyr, 1981; Wiesner et al., 1982; Silvestris and Heck, 1984; Hess and Knakal, 1985; Schobert, 1987; Kock et al., 1989; Allen et al., 1991; Janssen et al., 1991; IWVS, 1992; Snyder et al., 1992; Burroughs, 1993d

KULAN, *Equus hemionus*

Weight: 180–250 kg

Recommended Drug: 1.7 ml Large Animal Immobilon® plus 30 mg xylazine

Supplemental Drug: 1 ml Large Animal Immobilon®

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 1.5 mg etorphine plus 50 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 3 mg etorphine antagonize with 2 mg diprenorphine per mg etorphine given

References: Lanphear, 1963; Göltenboth and Klös, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; Hertzog, 1975; Jones, 1976; Oosterhuis, 1979; Wiesner et al., 1982; Kock and Pearce, 1985; Allen, 1990a

LANGUR, HANUMAN (INDIAN), *Semnopithecus entellus*

Weight: 10–23.6 kg

Recommended Drug: 3.3 mg/kg Telazol®

Supplemental Drug: 3.3 mg/kg ketamine

Antagonist: None

Alternative Drugs: 5 mg/kg ketamine

References: Beck, 1972; Beck and Dresner, 1972; Gray et al., 1974; Singh and Singh, 1982; Schobert, 1987

LECHWE, *Kobus leche*
Weight: 50–125 kg
Recommended Drug: 0.018 mg/kg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone per mg carfentanil given plus 0.125 mg/kg yohimbine
Alternative Drugs: 1.5 mg etorphine plus 30 mg ketamine plus 30 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
• 4 mg etorphine plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
Comments: Prone to excessive running during induction; monitor for hyperthermia. Also prone to sudden rear leg kicking when immobilized.
References: Kock et al., 1989; Allen et al., 1991; Snyder et al., 1992; Burroughs, 1993d

LECHWE, NILE, *Kobus megaceros*
Weight: 50–125 kg
Recommended Drug: 2.1 mg carfentanil (males); 1.5 mg carfentanil (females)
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Comments: Prone to excessive running during induction; monitor for hyperthermia. Also prone to sudden rear leg kicking when immobilized.
References: Allen et al., 1991

LEMMING, *Lemmus lemmus*
Weight: 40–112 gm
Recommended Drug: 0.0003 mg/gm medetomidine
Supplemental Drug: 0.00015 mg/gm medetomidine
Antagonist: 0.0015 mg/gm atipamezole
References: Love, 1970; Genevois et al., 1984a; Jalanka and Roeken, 1990

LEMUR, BLACK, *Eulemur macaco*
Weight: 2–3 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 6.6 mg/kg ketamine
Antagonist: None
Alternative Drugs: 12 mg/kg ketamine
References: Beck, 1972; Eads, 1976; Hugues et al., 1986; Schobert, 1987

LEMUR, RING-TAILED, *Lemur catta*
Weight: 2.3–3.5 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine

Antagonist: None
Alternative Drugs: 10 mg/kg ketamine plus 1 mg/kg xylazine; antagonize with 1 mg/kg tolazoline
• 12 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Beck and Dresner, 1972; Gray et al., 1974; Beck, 1976; Jessup et al., 1980; Schobert, 1987; Strauss, 1987

LEMUR, RUFFED, *Varecia variegata*
Weight: 3.2–4.5 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 12 mg/kg ketamine
References: Beck, 1976

LEOPARD, CLOUDED, *Panthera nebulaosa*
Weight: 16–23 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Bauditz, 1972; Beck, 1972; 1976; Hime, 1974; Boever et al., 1977; Nair, 1977; Jessup et al., 1980; Schobert, 1987

LEOPARD, *Panthera pardus*
Weight: 50–80 kg
Recommended Drug: 3 mg/kg ketamine plus 0.07 mg/kg medetomidine
Supplemental Drug: 2 mg/kg ketamine
Antagonist: 0.35 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 6.6 mg/kg Telazol®
• 11 mg/kg ketamine plus 1 mg/kg xylazine
References: Kroll, 1962; Young, 1966; Ericksen, 1968; Bennett and Tillotson, 1969; Pienaar et al., 1969; Seal and Erickson, 1969; Ebedes, 1970; 1973b; Göltenboth and Klös, 1970; Seal et al., 1970; Mathews, 1971; Bauditz, 1972; Beck, 1972; 1976; Holmes and Ngethe, 1973; Smuts et al., 1973; Foster, 1974; Gray et al., 1974; Hime, 1974; Seidensticker et al., 1974; Wentges, 1975; Wiesner, 1975; Bertram and King, 1976; Boever et al., 1977; King et al., 1977; Kuntze, 1977; Nair, 1977; Wiesner, 1977; Jessup et al., 1980; Genevois et al., 1984b; Pathak et al., 1985; Singh and Singh, 1985; Wiesner and von Hegel, 1985; Hugues et al., 1986; Göltenboth and Klös, 1987; Schobert, 1987; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; IWVS, 1992; Rogers, 1992; McKenzie and Burroughs, 1993

LEOPARD, SNOW, *Panthera uncia*

Weight: 25–75 kg

Recommended Drug: 3 mg/kg ketamine plus 0.08 mg/kg medetomidine

Supplemental Drug: 2 mg/kg ketamine

Antagonist: 0.4 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM

Alternative Drugs: 4 mg/kg Telazol®

- 10 mg/kg ketamine plus 2.2 mg/kg xylazine

References: Seal and Erickson, 1969; Seal et al., 1970; Dolensek, 1971; Beck, 1972; 1976; Wentges, 1975; Boever et al., 1977; Jessup et al., 1980; Fanton et al., 1984; Wiesner and von Hegel, 1985; Jalanka, 1987; 1989b; 1989c; Röken, 1987; Schobert, 1987; Barnett and Lewis, 1990; Jalanka and Roeken, 1990

LINSANG, BANDED, *Prionodon linsang*

Weight: 0.6–0.8 kg

Recommended Drug: 4.4 mg/kg Telazol®

Supplemental Drug: 4.4 mg/kg ketamine

Antagonist: None

References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Genevois et al., 1984b; Schobert, 1987

LION, *Panthera leo*

Weight: 100–250 kg

Recommended Drug: 2.5 mg/kg ketamine plus 0.07 mg/kg medetomidine

Supplemental Drug: 1.5 mg/kg ketamine

Antagonist: 0.35 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM

Alternative Drugs: 5 mg/kg Telazol®

- 7.5 mg/kg ketamine plus 3.5 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

Comments: Maintain vigilance for other members of the pride when working with an immobilized lion.

References: Heuschele, 1959; 1961a; Pistey and Wright, 1959; Clifford et al., 1960; 1962; Jarvis and Morris, 1960; Thomas, 1961; Harthoorn and Campbell, 1962; Campbell and Harthoorn, 1963; Larsen, 1963; Graham-Jones, 1964; Young, 1966; Wallach et al., 1967; Ericksen, 1968; Wallach, 1968; 1969; Bennett and Tillotson, 1969; Pienaar et al., 1969; Seal and Erickson, 1969; Krahwinkel, 1970; Seal et al., 1970; Ebedes, 1970; 1973b; Gass, 1970; Göltenboth and Klös, 1970; Krahwinkel, 1970; Bennet et al., 1971; Harthoorn et al., 1971; Bauditz, 1972; Beck, 1972; 1976; York and Huggins, 1972; Holmes and Ngethe, 1973; Smuts et al., 1973; York, 1973; Young and Whyte, 1973; Alford et al., 1974; Eltringham, 1974; Gray et al., 1974; Hime, 1974; Wentges, 1975; Bertram, 1976; Bertram and King, 1976; Boever et al., 1977; King et al., 1977; Kuntze, 1977; Nair, 1977; Wiesner, 1977; Bush et al., 1978; Jessup et al., 1980; Arora et al., 1983; Genevois et al., 1984b; Herbst et al., 1985; Wiesner and von Hegel, 1985; Hugues et al., 1986; Gonzales and McDonnel, 1986; Van Wyk and Berry, 1986; Röken, 1987;

Schobert, 1987; Kock et al., 1989; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Stander and Morkel, 1991; IWVS, 1992; Chandrasekara Pillai, 1992; Rogers, 1992; McKenzie and Burroughs, 1993

LION, MOUNTAIN, *Felis concolor*

Weight: 30–75 kg

Recommended Drug: 2 mg/kg ketamine plus 0.075 mg/kg medetomidine

Supplemental Drug: 1 mg/kg ketamine

Antagonist: 0.3 mg/kg atipamezole

Alternative Drugs: 8 mg/kg Telazol®

• 10 mg/kg ketamine plus 2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

References: Heuschele, 1959; Graham-Jones, 1964; Hornocker et al., 1965; Young, 1966; Seal and Erickson, 1969; Göltenboth and Klös, 1970; Seal et al., 1970; Bauditz, 1972; Hornocker and Wiles, 1972; Gray et al., 1974; Hime, 1974; Beck, 1976; Boever et al., 1977; Kuntze, 1977; Wiesner, 1977; Jessup et al., 1980; Jessup, 1982b; Genevois et al., 1984b; Wiesner and von Hegel, 1985; Gonzales and McDonnel, 1986; Logan et al., 1986; Logan et al., 1987; Schobert, 1987; Seal and Kreeger, 1987; Pond and O'Gara, 1994

LIZARDS/SKINKS, GENERAL

Recommended Drug: 50 mg/kg ketamine

Supplemental Drug: 25 mg/kg ketamine

Antagonist: None

Alternative Drugs: 30 mg/kg Telazol®

References: Brazenor and Kaye, 1953; Cooper, 1974; Beck, 1976; Wang et al., 1977; Throckmorton, 1981; Amand, 1982b; Garver and Jackson, 1985; Ogunranti, 1987; Arena et al., 1988; Johnson, 1991; Page, 1993

LLAMA, *Lama glama*

Weight: 130–155 kg

Recommended Drug: 1 mg/kg ketamine plus 0.05 mg/kg medetomidine

Supplemental Drug: 1 mg/kg ketamine

Antagonist: 0.25 mg/kg atipamezole

Alternative Drugs: 2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

• 4 mg/kg Telazol®

Comments: The use of opioids in llama is contraindicated (Jones, 1977a).

References: Jarvis and Morris, 1960; Kroll, 1962; Seal and Erickson, 1969; Seal et al., 1970; Gauckler and Kraus, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; Beck, 1972; 1976; York and Huggins, 1972; Rapley and Mehren, 1975; Jones, 1977a; Slee and Walker, 1977; Jessup et al., 1980; Wiesner et al., 1982; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Gavier et al., 1986; Hugues et al., 1986; Riebold et al., 1986; Jalanka and Roeken, 1990

LORIS, SLOW, *Nycticebus coucang*
Weight: 0.4–2 kg
Recommended Drug: 11 mg/kg ketamine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970; Schulz and Silverman, 1973; Beck, 1976

LYNX, EUROPEAN, *Felis lynx*
Weight: 8–38 kg
Recommended Drug: 3 mg/kg ketamine plus 0.09 mg/kg medetomidine
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: 0.45 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 5 mg/kg Telazol®
• 10 mg/kg ketamine plus 1.5 mg/kg xylazine
References: Heuschele, 1961; Wiesner, 1977; Oen, 1980; Wiesner and von Hegel, 1985; Jalanka and Roeken, 1990

LYNX, IBERIAN, *Felis pardina*
Weight: 10–12 kg
Recommended Drug: 4 mg/kg ketamine plus 4 mg/kg xylazine
Supplemental Drug: 2 mg/kg ketamine
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 5 mg/kg Telazol®
• 10 mg/kg ketamine plus 1.5 mg/kg xylazine
References: Ferreras et al., 1994

LYNX, *Lynx canadensis*
Weight: 5.1–17.2 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine plus 2 mg/kg xylazine
References: Heuschele, 1961b; Seal and Erickson, 1969; Seal et al., 1970; Berrie, 1972; Jessup, 1982b; Duchamps, 1985; Seal and Kreeger, 1987; Poole et al., 1993; Pond and O'Gara, 1994

MACAQUE, BONNET, *Macaca radiata*
Weight: 5–15 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 25 mg/kg ketamine
References: Beck, 1972; Gray et al., 1974; Beck and Dresner, 1972; Jessup et al., 1980; Schobert, 1987

MACAQUE, CRAB-EATING (CYNOMOLGUS), *Macaca fascicularis*
Weight: 5–15 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 20 mg/kg ketamine
References: Graham-Jones, 1964; Beck, 1972; 1976; Beck and Dresner, 1972; Gray et al., 1974; Eads, 1976; Vercruysse and Mortelmans, 1978; Jessup et al., 1980; Castro et al., 1981; Schobert, 1987

MACAQUE, JAPANESE, *Macaca fuscata*
Weight: 5–15 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 22 mg/kg ketamine
References: Seal et al., 1970; Beck, 1972; 1976; Jessup et al., 1980

MACAQUE, LION-TAIL, *Macaca silenus*
Weight: 5–15 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 22 mg/kg ketamine
References: Gray et al., 1974; Beck, 1976; Eads, 1976; Bush et al., 1977; Jessup et al., 1980; Singh and Singh, 1982; Schobert, 1987

MACAQUE, PIG-TAIL, *Macaca nemestrina*
Weight: 5–15 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 22 mg/kg ketamine
References: Heuschele, 1961a; 1961b; Larsen, 1963; Field et al., 1966; Seal et al., 1970; Bauditz, 1972; Beck, 1972; Beck and Dresner, 1972; Crittal and Smith, 1972; Gray et al., 1974; Eads, 1976; Bush et al., 1977; Jessup et al, 1980; Schobert, 1987

MACAQUE, STUMP-TAILED, *Macaca arctoides*
Weight: 5–15 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 22 mg/kg ketamine
References: Beck, 1972; 1976; Beck and Dresner, 1972; Gray et al., 1974;

Eads, 1976; Jessup et al., 1980; Schobert, 1987

MACAQUE, TOQUE, *Macaca sinica*
Weight: 2.5–6.1 kg
Recommended Drug: 2.6 mg/kg Telazol®
Supplemental Drug: 2.6 mg/kg ketamine
Antagonist: None
References: Gray et al., 1974; Schobert, 1987

MANDRILL, *Mandrillus sphinx*
Weight: 20–54 kg
Recommended Drug: 2.2 mg/kg Telazol®
Supplemental Drug: 2.2 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Beck, 1976; Schobert, 1987

MANGABEY, GRAY-CHEEKED, *Cercocebus albigena*
Weight: 5–20 kg
Recommended Drug: 3 mg/kg Telazol®
Supplemental Drug: 3 mg/kg ketamine
Antagonist: None
References: Schobert, 1987

MANGABEY, SOOTY, *Cercocebus torquatis*
Weight: 5–20 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 12.5 mg/kg ketamine
References: Marsboom et al., 1963; Seal and Erickson, 1969; Seal et al., 1970; Field et al., 1966; Beck, 1972; Beck and Dresner, 1972; Gray et al., 1974; Schobert, 1987

MARA - SEE CAVY

MARGAY, *Felis tiedii*
Weight: 2.6–3.4 kg
Recommended Drug: 8.8 mg/kg Telazol®
Supplemental Drug: 8.8 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 1 mg/kg xylazine
References: Seal and Erickson, 1969; Seal et al., 1970; Hime, 1974; Beck, 1976; Seal and Kreeger, 1987

MARKHOR, *Capra falconeri*
Weight: 80–100 kg
Recommended Drug: 2 mg/kg ketamine plus 0.08 mg/kg medetomidine
Supplemental Drug: 1 mg/kg ketamine only
Antagonist: 0.4 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.022 mg/kg carfentanil; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given
• 2 mg etorphine plus 20 mg ketamine plus 20 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
• 0.7 ml Large Animal Immobilon® plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
Comments: Rapid, smooth induction (< 5 min) and antagonism (< 10 min) with ketamine/medetomidine.
References: Wiesner, 1975; 1977; Jensen, 1982; Wiesner et al., 1982; 1984; Jalanka, 1987; 1988; 1989a; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Allen et al., 1991; Snyder et al., 1992

MARMOSET, COTTON TOP - SEE TAMARIN, COTTON HEADED

MARMOSET, GOLDEN - SEE TAMARIN, GOLDEN LION

MARMOSET, SHORT-TUSKED, *Callithrix jacchus*
Weight: 230–453 gm
Recommended Drug: 0.0022 mg/gm Telazol®
Supplemental Drug: 0.0022 mg/gm ketamine
Antagonist: None
Alternative Drugs: 0.005 mg/gm ketamine plus 0.0001 mg/gm medetomidine
References: Gray et al., 1974; Jalanka and Roeken, 1990

MARMOT, HOARY, *Marmota caligata*
Weight: 3–7.5 kg
Recommended Drug: 0.3 ml/kg Innovar-Vet®
Antagonist: 0.2 mg/kg naloxone
References: Noyes and Siekierski, 1975

MARTEN, PINE, *Martes americanas*
Weight: 0.5–1.5 kg
Recommended Drug: 10 mg/kg ketamine plus 0.2 mg/kg medetomidine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: 1 mg/kg atipamezole
Alternative Drugs: 60 mg/kg ketamine plus 12 mg/kg xylazine
Comments: A gas-anesthesia machine designed for field use has been successfully used on marten (Herman et al., 1982). Avoid overheating.
References: Jonkel and Weckworth, 1963; Birnbaum et al., 1969; Seal and Erickson, 1969; Seal et al., 1970; Mech, 1974; Wilson, 1976; More, 1977;

Jessup et al., 1980; Herman et al., 1982; Jessup, 1982b; Wiesner and von Hegel, 1985; Seal and Kreeger, 1987; Jalanka and Roeken, 1990; Belant, 1992; Arnemo et al., 1994c

MINK, *Mustela vison*
Weight: 0.8–1.1 kg
Recommended Drug: 15 mg/kg Telazol®
Supplemental Drug: 15 mg/kg ketamine
Antagonist: None
Alternative Drugs: 5 mg/kg ketamine plus 0.1 mg/kg medetomidine
• 40 mg/kg ketamine plus 1 mg/kg xylazine
References: Fuhrman and Stuhr, 1941; Sandelien, 1966; Graham et al., 1967; Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; 1976; Gray et al., 1974; Ramsden et al., 1976; Boever et al., 1977; Jessup et al., 1980; Jepsen et al., 1981; Hoilien and Oates, 1982; Jessup, 1982b; Wright, 1983; Genevois et al., 1984b; Schobert, 1987; Seal and Kreeger, 1987; Jalanka and Roeken, 1990; Arnemo and SØli, 1992

MONGOOSE, AFRICAN WATER, *Atilax paludinosus*
Weight: 2.5–4.1 kg
Recommended Drug: 5.5 mg/kg Telazol®
Supplemental Drug: 5.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 45 mg/kg ketamine
References: Seal et al., 1970; Gray et al., 1974; Genevois et al., 1984b; Schobert, 1987; Maddock, 1989

MONGOOSE, BLACK-LEGGED, *Bdeogale spp.*
Weight: 0.9–3 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
References: Seal et al., 1970; Gray et al., 1974; Schobert, 1987

MONGOOSE, *Herpestes spp.*
Weight: 0.4–4 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 30 mg/kg ketamine plus 0.75 mg/kg acepromazine
• 6 mg/kg ketamine plus 6 mg/kg xylazine
• 45 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Beltrán et al., 1985; Maddock, 1989; Palomares and Delibes, 1992; McKenzie and Burroughs, 1993

MONGOOSE, MALAGASY RING-TAILED, *Galidia elegans*
Weight: 0.7–0.9 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Seal et al., 1970; Gray et al., 1974; Genevois et al., 1984b

MONKEY, AFRICAN GREEN - SEE MONKEY (GUENON), GREEN

MONKEY (GUENON), BLACK-CHEEKED, *Cercopithecus ascanius*
Weight: 1.8–6.4 kg
Recommended Drug: 18 mg/kg ketamine plus 1.8 mg/kg xylazine
Supplemental Drug: 9 mg/kg ketamine
Antagonist: None reported
References: Jones and Bush, 1988

MONKEY (GUENON), DEBRAZZA'S, *Cercopithecus neglectus*
Weight: 4.5–7.8 kg
Recommended Drug: 4.75 mg/kg Telazol®
Supplemental Drug: 4.75 mg/kg ketamine
Antagonist: None
References: Schobert, 1987

MONKEY (GUENON), DIANA, *Cercopithecus diana*
Weight: 3–6 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Eads, 1976; Schobert, 1987

MONKEY (GUENON), GREEN, *Cercopithecus sabaeus*
Weight: 3–6 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine
References: Seal et al., 1970; Beck, 1972; Gray et al., 1974; Eads, 1976; Bush et al., 1977; Jessup et al., 1980; Schobert, 1987

MONKEY (GUENON), GRIVET, *Cercopithecus aethiops*
Weight: 5–9 kg
Recommended Drug: 7 mg/kg Telazol®
Supplemental Drug: 4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 27 mg/kg ketamine

References: Seal and Erickson, 1969; Beck and Dresner, 1972

MONKEY (GUENON), MONA, *Cercopithecus mona*
Weight: 3–6 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Gray et al., 1974; Schobert, 1987

MONKEY (GUENON), SYKES, *Cercopithecus albogularis*
Weight: 3–6 kg
Recommended Drug: 3 mg/kg Telazol®
Supplemental Drug: 3 mg/kg ketamine
Antagonist: None
Alternative Drugs: 25 mg/kg ketamine
References: Gray et al., 1974; Beck, 1976; Schobert, 1987

MONKEY, ALLEN'S, *Allenopithecus nigroviridis*
Weight: 3.5–6 kg
Recommended Drug: 2.2 mg/kg Telazol®
Supplemental Drug: 2.2 mg/kg ketamine
Antagonist: None
References: Gray et al., 1974; Schobert, 1987

MONKEY, CAPUCHIN, *Cebus spp.*
Weight: 1.1–3.3 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 25 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; Beck and Dresner, 1972; Gray et al., 1974; Eads, 1976; Jessup et al., 1980; Schobert, 1987

MONKEY, COLOBUS, *Colobus spp.*
Weight: 5.4–14.5 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine
References: Kroll, 1962; Gray et al., 1974; Bush et al., 1977; Schobert, 1987

MONKEY, HOWLER, *Alouatta spp.*
Weight: 4–10 kg
Recommended Drug: 20 mg/kg Telazol®

Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
References: Bush et al., 1977; Schobert, 1987; Glander et al., 1991; Agoramoorthy and Rudran, 1994

MONKEY, NIGHT (DOUROUCOULIS), *Aotus trivirgatus*
Weight: 0.6–1 kg
Recommended Drug: 22 mg/kg ketamine
Supplemental Drug: 11 mg/kg ketamine
Antagonist: None
References: Beck, 1972; Beck and Dresner, 1972; Jessup et al., 1980

MONKEY, PATAS, *Erythrocebus patus*
Weight: 4–13 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; 1976; Beck and Dresner, 1972; Gray et al., 1974; Eads, 1976; Bush et al., 1977; Jessup et al., 1980; Schobert, 1987

MONKEY, PROBOSCIS, *Nasalis larvatus*
Weight: 7–11 (f), 16–22.5 (m) kg
Recommended Drug: 22 mg/kg ketamine
Supplemental Drug: 11 mg/kg ketamine
Antagonist: None
References: Heuschele, 1961; Beck, 1976

MONKEY, RHESUS, *Macaca mulatta*
Weight: 9–12 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 6.6 mg/kg ketamine
Antagonist: None
Alternative Drugs: 2.5 mg/kg ketamine plus 2 mg/kg xylazine
• 22 mg/kg ketamine
References: Marsboom et al., 1963; Ericksen, 1968; Seal and Erickson, 1969; Seal et al., 1970; Bauditz, 1972; Beck, 1972; Beck and Dresner, 1972; Alford et al., 1974; Gray et al., 1974; Eads, 1976; Ferin et al., 1976; Channing et al., 1977; Banknieder et al., 1978; Cohen and Bree, 1978; Naccarato and Hunter, 1979; Jessup et al., 1980; Puri et al., 1981; Porter, 1982a; 1982b; Fuller et al., 1984; Hess and Knakal, 1985; Hess et al., 1987; Schobert, 1987

MONKEY, SPIDER, *Ateles spp.*
Weight: 4–6 kg

Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 30 mg/kg ketamine
References: Jarvis and Morris, 1960; Thomas, 1961; Kroll, 1962; Wallach et al., 1967; Wallach, 1968; 1969; Seal et al., 1970; Bauditz, 1972; Beck, 1976; Gray et al., 1974; Eads, 1976; Bush et al., 1977; Schobert, 1987

MONKEY, SQUIRREL, *Saimiri spp.*
Weight: 0.7–1.1 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 25 mg/kg ketamine
References: Marsboom et al., 1963; Wallach, 1968; 1969; Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; Beck and Dresner, 1972; Gray et al., 1974; Eads, 1976; Jessup et al., 1980; Schobert, 1987

MONKEY, TOQUE - SEE MACAQUE, TOQUE

MONKEY, WOOLY, *Lagothrix spp.*
Weight: 5.5–10.8 kg
Recommended Drug: 7 mg/kg Telazol®
Supplemental Drug: 7 mg/kg ketamine
Antagonist: None
Alternative Drugs: 20 mg/kg ketamine
References: Wallach et al., 1967; Wallach, 1968; 1969; Beck, 1972; 1976; Gray et al., 1974; Jessup et al., 1980; Schobert, 1987

MOOSE, *Alces alces*
Weight: 400–600 kg
Recommended Drug: 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine
Supplemental Drug: If animal is not down in 20 min, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.1 mg/kg yohimbine IV; may also give same doses IM along with IV to decrease renarcotization
Alternative Drugs: 1.5 mg/kg ketamine plus 0.06 mg/kg medetomidine; antagonize with 0.3 mg/kg atipamezole
- 4 mg/kg ketamine plus 1 mg/kg xylazine; antagonize with 0.25 mg/kg tolazoline
- 0.02 mg/kg etorphine plus 0.5 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg tolazoline
- 5 mg/kg Telazol®
- 3 mg/kg xylazine, antagonize with 0.06 mg/kg idazoxan or 0.75 mg/kg tolazoline (calm animals only)

Comments: Increased mortality and complications have been observed when *underdosing* with etorphine. Renarcotization is possible with either opioid anesthetic; give equal doses of the antagonists both IV and IM. When using xylazine alone, better results may be obtained by concentrating the solution (300 mg/ml; Doherty and Tweedie, 1989) and antagonize with tolazoline.
References: Pimlott and Carberry, 1958; Rausch and Ritcey, 1961; Bergerud et al., 1964; Nielson and Shaw, 1967; Houston, 1969; 1970; Bauditz, 1972; Alford et al., 1974; Franzmann and Arneson, 1974; Gray et al., 1974; Roussel and Pichette, 1974; Franzmann et al., 1975; 1982; 1984; 1987; Roussel and Patenaude, 1975; Rapley and Mehren, 1975; Wiesner, 1975; 1977; Haigh, 1976d; Haigh et al., 1977; Gasaway et al., 1978; Joyal et al., 1978; Haigh, 1979; Smith and Franzmann, 1979; Jarofke, 1980; Jones, 1978; 1984; Jessup et al., 1980; Ballard and Tobey, 1981; Lynch and Hanson, 1981; Franzmann, 1982; Thorne, 1982; Schwab et al., 1984; Wiesner et al., 1984; Kock and Pearce, 1985; Röken, 1985; Seal et al., 1985b; Sedgwick, 1986; Schmitt and Dalton, 1987; Sandegren et al., 1987; Schobert, 1987; Seal and Bush, 1987; Williams and Riedesel, 1987; Franzmann and Lance, 1988; Schmitt and Aho, 1988; Doherty and Tweedie, 1989; Stanley et al., 1989; Jalanka and Roeken, 1990; Schwartz et al., 1991; Arnemo et al., 1994a; Garner and Addison, 1994a; 1994b; Pond and O'Gara, 1994

MOUFLON, *Ovis musimon*
Weight: 20–32 kg
Recommended Drug: 2.5 mg/kg ketamine plus 0.125 mg/kg medetomidine
Supplemental Drug: 1.5 mg/kg ketamine
Antagonist: 0.6 mg/kg atipamezole
Alternative Drugs: 0.01 mg/kg carfentanil plus 0.25 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
- 7 mg/kg Telazol®
- 0.7 ml Large Animal Immobilon® plus 20 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 2 mg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
- 0.05 mg/kg fentanyl plus 0.5 mg/kg xylazine; antagonize with 0.2 mg/kg naloxone plus 0.125 mg/kg yohimbine

References: Honich, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; York and Huggins, 1972; Boever and Paluch, 1974; Gray et al., 1974; York, 1975; Wiesner, 1977; Jessup, et al., 1980; Wiesner et al., 1982; 1984; Duchamps, 1985; Hugues et al., 1986; Macek, 1987; Röken, 1987; Schobert, 1987; Barnett and Lewis, 1990; Jalanka and Roeken, 1990; Allen et al., 1991

MOUSE, BRUSH-TAILED MARSUPIAL, *Phascogale tapoatafa*
Weight: 110–135 gm
Recommended Drug: 0.01 mg/gm Telazol®

Supplemental Drug: 0.01 mg/gm ketamine
Antagonist: None
References: Holz, 1992

MOUSE, GENERAL
Weight: 5–110 gm
Recommended Drug: 0.044 mg/gm ketamine plus 0.006 mg/gm xylazine
Supplemental Drug: 0.022 mg/gm ketamine
Antagonist: None reported
Alternative Drugs: Ether or methoxyflurane gas anesthesia
Comments: Mice can be effectively anesthetized using a jar and cotton swabs soaked in ether or methoxyflurane; monitor closely and remove as soon as the animal becomes unconscious.
References: Weisbroth and Fudens, 1972; Stunkard and Miller, 1974; Hughes et al., 1975; Rauch and Beatty, 1977; Mulder, 1978b; Baumgardner and Dewsbury, 1979; Genevois et al., 1984a; Garver and Jackson, 1985

MUNTJAC, *Muntiacus muntjak*
Weight: 14–28 kg
Recommended Drug: 3.3 mg/kg ketamine plus 3.3 mg/kg xylazine
Supplemental Drug: 2 mg/kg ketamine
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 0.007 mg/kg carfentanil plus 0.05 mg/kg xylazine; antagonize with 100 mg naltexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
• 0.1 ml Large Animal Immobilon® plus 3 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given
References: Heck and Rivenburg, 1972; Cooper et al., 1984; Seidel and Strauss, 1984; Jensen, 1982; Wiesner et al., 1982; 1984; Arora et al., 1983; Wiesner and von Hegel, 1985; Göltenboth and Klös, 1987; Seal and Bush, 1987

MUNTJAC, REEVES, *Muntiacus reevesi*
Weight: 14–28 kg
Recommended Drug: 3.3 mg/kg ketamine plus 3.3 mg/kg xylazine
Supplemental Drug: 2 mg/kg ketamine
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 8 mg/kg Telazol®
• 0.06 mg/kg etorphine plus 0.025 mg/kg acepromazine; antagonize with 2 mg diprenorphine per mg etorphine given
References: Heck and Rivenburg, 1972; Jones, 1972; 1984; Beck, 1976; Seidel and Strauss, 1984; Cooper et al., 1986; Seal and Bush, 1987; Kock et al., 1989; Bush et al., 1992

MUSKOX, *Ovibos moschatus*

Weight: 200–410 kg

Recommended Drug: 0.0125 mg/kg etorphine plus 0.1 mg/kg xylazine

Supplemental Drug: If not down in 20 min, repeat full dose

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 1.5 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

Comments: Muskoxen easily overheat in warm weather. It is best to capture them on cool days or during the coolest part of the day. During the rutting season, bulls may require less xylazine (0.5 mg/kg) if you choose to use xylazine alone.

References: Jones, 1971a; 1971b; Bauditz, 1972; Heck and Rivenburg, 1972; Jonkel et al., 1975; Seidel, 1979; Patenaude, 1982b; Wiesner et al., 1982; Reynolds and Garner, 1983; Clausen et al., 1984; Dieterich, 1984; White et al., 1985; Kock et al., 1989; Clausen, 1994

MUSKRAT, *Ondatra zibethicus*

Weight: 0.7–1.8 kg

Recommended Drug: 15 mg/kg ketamine plus 0.75 mg/kg xylazine

Supplemental Drug: 10 mg/kg ketamine

Antagonist: 0.125 mg/kg yohimbine

Alternative Drugs: Gas anesthesia such as methoxyflurane or isoflurane

References: Hoilien and Oates, 1982; Seal and Kreeger, 1987; Blanchette, 1989; Lacki et al., 1989; Belant, 1995; 1996

NILGAI, *Boselaphus tragocamelus*

Weight: 170–240 kg

Recommended Drug: 3.9 mg carfentanil (males); 3 mg carfentanil (females)

Supplemental Drug: If animal is not down in 20 min, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given

Alternative Drugs: 6 mg etorphine; antagonize with antagonize with 2 mg diprenorphine per mg etorphine given

- 1.8 ml Large Animal Immobilon® plus 10 mg xylazine antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 3 mg/kg xylazine; antagonize with 0.2 mg/kg yohimbine (calm animals only)

Comments: Prone to excessive running during induction with opioids; monitor for hyperthermia.

References: Jarvis and Morris, 1960; Heuschele, 1961a; Wright, 1963; Gauckler and Kraus, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; York and Huggins, 1972; Hertzog, 1975; Mehren and Rapley, 1975; Rapley and Mehren, 1975; York, 1975; Jessup et al., 1980; Singh and Singh, 1982; Wiesner et al., 1982; Silvestris and Heck, 1984; Althouse et al., 1987; Arora, 1988; Kock et al., 1989; Allen et al., 1991

NUTRIA, *Myocastor coypus*

Weight: 5–10 kg

Recommended Drug: 5 mg/kg Telazol®

Supplemental Drug: 5 mg/kg ketamine

Antagonist: None

Alternative Drugs: 4 mg/kg ketamine plus 0.5 mg/kg xylazine

• 5 mg/kg ketamine plus 0.1 mg/kg medetomidine

References: Murry and Dennett, 1963; Van Foreest, 1980; Seal and Kreeger, 1987; Jalanka and Roeken, 1990; Bó et al., 1994

NYALA, *Tragelaphus angasi*

Weight: 60–100 kg

Recommended Drug: 0.04 mg/kg etorphine plus 0.3 mg/kg xylazine

Supplemental Drug: 0.02 mg/kg etorphine

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 1 mg etorphine plus 60 mg ketamine plus 60 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine

• 0.7 ml Large Animal Immobilon® plus 5 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine

• 11 mg/kg Telazol®

Comments: Nyala are prone to capture myopathy. Use careful dart placement to avoid trauma in small- to medium-sized animals.

References: Bauditz, 1972; Heck and Rivenburg, 1972; Pienaar, 1973a; Gray et al., 1974; Rapley and Mehren, 1975; Röken, 1975; York, 1975; Haigh, 1976d; Wiesner et al., 1982; Silvestris and Heck, 1984; Schobert, 1987; Kock et al., 1989; Flamand and Rogers, 1992; IWVS, 1992; Burroughs, 1993d

OCEOLOT, *Felis pardalis*

Weight: 11.3–15.8 kg

Recommended Drug: 8 mg/kg Telazol®

Supplemental Drug: 5 mg/kg ketamine

Antagonist: None

Alternative Drugs: 15 mg/kg ketamine plus 1 mg/kg xylazine

References: Larsen, 1963; Seal and Erickson, 1969; Seal et al., 1970; Hime, 1974; Wiesner and von Hegel, 1985; Seal and Kreeger, 1987; Crawshaw and Quigley, 1989; Beltrán and Tewes, 1995

OKAPI, *Okapia johnstoni*

Weight: 200–250 kg

Recommended Drug: 2 mg/kg fentanyl plus 0.05 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 0.2 mg/kg naloxone plus 0.2 mg/kg yohimbine

References: Mortelmans, 1978

OLINGO, *Bassaricyon gabbii*
Weight: 0.9–1.5 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970

ONAGER - SEE KULAN

OPOSSUM, NORTH AMERICAN, *Didelphis virginianus*
Weight: 2–5.5 kg
Recommended Drug: 10 mg/kg ketamine plus 2 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None reported
Alternative Drugs: 5 mg/kg Telazol®
- 20 mg/kg ketamine

References: Mosby and Cantner, 1956; Seal and Erickson, 1969; Seal et al., 1970; Feldman and Self, 1971; Beck, 1972; 1976; Haupert and Lindeen, 1974; Hughes et al., 1975; Smeller et al., 1977; Hoilien and Oates, 1982; Scott and Kolata, 1982; Wright, 1983; Seal and Kreeger, 1987

ORANGUTAN, *Pongo pygmaeus*
Weight: 30–50 (f), 50–70 (m) kg
Recommended Drug: 3.5 mg/kg Telazol®
Supplemental Drug: 3.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 6.5 mg/kg ketamine plus 0.8 mg/kg xylazine
References: Kroll, 1962; Wallach et al., 1967; Seal et al., 1970; Beck, 1972; Beck and Dresner, 1972; Gray et al., 1974; Bush et al., 1977; Vercruysse and Mortelmans, 1978; Jessup et al., 1980; Robinson and Lambert, 1986; Göltenboth and Klös, 1987; Schobert, 1987; Kock et al., 1989; Andau et al., 1994

ORIBI, *Ourebia ourebi*
Weight: 14–21 kg
Recommended Drug: 0.01 mg/kg etorphine plus 0.4 mg/kg xylazine
Supplemental Drug: 0.005 mg/kg etorphine
Antagonist: 2 mg/kg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
Alternative Drugs: 0.2 mg/kg fentanyl plus 0.4 mg/kg xylazine
- 8 mg fentanyl plus 30 mg azaperone
- 6 mg/kg Telazol®

Comments: Monitor for respiratory depression when using opioids.
References: Van Niekerk et al., 1963a; Pienaar and Van Niekerk, 1963; Viljoen, 1981; IWVS, 1992; Burroughs, 1993d

ORYX, ARABIAN, *Oryx leucoryx*

Weight: 80–120 kg

Recommended Drug: 3 mg carfentanil plus 5 mg xylazine

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 2 mg/kg Telazol® plus 0.2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine

- 0.03 mg/kg etorphine plus 0.3 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 0.05 mg/kg etorphine plus 0.005 mg/kg medetomidine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.025 mg/kg atipamezole
- 0.5 mg/kg xylazine; antagonize with 0.09 mg/kg atipamezole or 0.125 mg/kg yohimbine (calm animals only)
- 0.05 mg/kg medetomidine; antagonize with 0.25 mg/kg atipamezole (calm animals only)

References: Graham-Jones, 1964; Machado et al., 1983; Kock et al., 1989; Allen et al., 1991; Bush et al., 1992; Greth et al., 1993; Ancrenaz, 1994; Ancrenaz et al., 1995; 1996

ORYX, SCIMITAR-HORNED, *Oryx dammah*

Weight: 100–210 kg

Recommended Drug: 3 mg carfentanil plus 10 mg xylazine (males); 2.5 mg carfentanil (females)

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 0.04 mg/kg etorphine plus 0.05 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 9.4 mg/kg Telazol®
- 3 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine (calm animals only)

References: Bauditz, 1972; Heck and Rivenburg, 1972; Rapley and Mehren, 1975; Röken, 1975; Silvestris and Heck, 1984; Kock et al., 1989; Allen et al., 1991; Majonica and Bonath, 1993

OSTRICH, *Struthio camelus*

Weight: 100–200 kg

Recommended Drug: 3 mg carfentanil plus 150 mg xylazine

Supplemental Drug: 1.5 mg carfentanil

Antagonist: 100 mg naltrexone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 3.6 mg etorphine plus 25 mg acepromazine plus 200 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus

0.125 mg/kg yohimbine

- 10 mg/kg ketamine plus 0.5 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
- 12.5 mg/kg Telazol®

Comments: Ostriches have thin skin; use low-impact darts. They are also highly susceptible to complications and capture myopathy if pursued or handled roughly. Avoid capture at temperatures > 28° C (82.4° F). Upon induction and recovery, ostriches may thrash with their head and neck, resulting in injury; underdosing tends to exacerbate this head thrashing. Attempt to immobilize and restrain the bird as quickly as possible. Do not approach birds until fully recumbent because this may stimulate them to rise and prolong induction. Ostriches have a thick (50 mm) layer of fat under the skin in the abdominal region which can slow down drug absorption if injected in this site. The primary targets are the muscle masses of the legs and back. Telazol® or ketamine may result in prolonged and/or rough recoveries; diazepam (1 mg/kg) may be given IV as soon as the animal attempts to rise to smooth recovery. If diprenorphine is used to antagonize opioid anesthesia, monitor for 24 hours for renarcotization. Xylazine should be avoided in very sick birds.

References: Harthoorn, 1971; Blackshaw and Wakeman, 1972; York and Huggins, 1972; Robinson and Fairfield, 1974; Beck, 1976; Stoskopf et al., 1982; Gandini et al., 1986; Schobert, 1987; Samour et al., 1990; Van Heerden and Keffen, 1991; Cornick and Jensen, 1992; IWVS, 1992; Raath et al., 1992; Keffen, 1993; Matthews, 1993; Jensen et al., 1994

OTTER, AMERICAN RIVER, *Lutra canadensis*

Weight: 7–9 kg

Recommended Drug: 5.5 mg/kg Telazol®

Supplemental Drug: 3.7 mg/kg ketamine

Antagonist: None

Alternative Drugs: 2.5 mg/kg ketamine plus 0.05 mg/kg medetomidine; antagonize with 0.2 mg/kg atipamezole

- 10 mg/kg ketamine plus 0.25 mg/kg midazolam
- 7.5 mg/kg ketamine plus 1.5 mg/kg xylazine

References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Boever et al., 1977; Kane, 1979; Jessup et al., 1980; Jenkins and Gorman, 1981; Jessup, 1982b; Elmore et al., 1985; Genevois et al., 1984b; Hoover, 1984; 1985; Hoover et al., 1984; Woolf et al., 1984; Elmore et al., 1985; Hoover and Jones, 1986; Erickson and McCullough, 1987; Göltenboth and Klös, 1987; Schobert, 1987; Spelman et al., 1993a; 1993b; 1994

OTTER, ASIAN SMALL-CLAWED, *Aonyx cinerea*

Weight: 1–5 kg

Recommended Drug: 5 mg/kg ketamine plus 0.12 mg/kg medetomidine

Supplemental Drug: 2.5 mg/kg ketamine

Antagonist: 0.6 mg/kg atipamezole
Alternative Drugs: 5.5 mg/kg Telazol®
• 10 mg/kg ketamine
References: Seal and Erickson, 1969; Seal et al., 1970; Beck, 1976; Kane, 1979; Lindsay and Lloyd, 1991

OTTER, CLAWLESS, *Aonyx capensis*
Weight: 13–34 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 8 mg/kg ketamine plus 1 mg/kg xylazine
References: McKenzie and Burroughs, 1993

OTTER, EUROPEAN, *Lutra lutra*
Weight: 3–14 kg
Recommended Drug: 50 mg/kg ketamine plus 3 mg/kg xylazine
Supplemental Drug: 25 mg/kg ketamine
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 15 mg/kg ketamine plus 0.5 mg/kg diazepam
References: Holmes, 1974; Jenkins and Gorman, 1981; Reuther, 1983; Reuther and Brandes, 1984; Wiesner and von Hegel, 1985; Kuiken, 1988; Arnemo, 1989

OTTER, SEA, *Enhydra lutris*
Weight: 15–32 (f), 22–45 (m) kg
Recommended Drug: 0.3 mg/kg fentanyl plus 0.25 mg/kg azaperone
Supplemental Drug: 0.15 mg/kg fentanyl
Antagonist: 0.3 mg/kg naloxone
Alternative Drugs: 0.2 mg/kg fentanyl plus 1 mg/kg xylazine, antagonize with 0.2 mg/kg naloxone and 0.15 mg/kg yohimbine
• 3 mg/kg Telazol®
Comments: Avoid overheating by monitoring rectal temperature.
References: Stullken and Kirkpatrick, 1955; Williams, 1978; 1990; Williams and Kocher, 1978; Jessup et al., 1980; Williams et al., 1981; 1990a; 1990b; 1992; Jessup, 1982b; Joseph et al., 1987; Schobert, 1987; Seal and Kreeger, 1987

OTTER, SPOTTED-NECKED, *Lutra maculicollis*
Weight: 3–14 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 8 mg/kg ketamine plus 1 mg/kg xylazine
References: McKenzie and Burroughs, 1993

OWL, BARN, *Tyto alba*
Weight: 600–800 gm
Recommended Drug: 0.03 mg/gm Telazol®
Supplemental Drug: 0.03 mg/gm ketamine
Antagonist: None
References: Camburn and Stead, 1978; Schobert, 1987

OWL, BARRED, *Strix varia*
Weight: 500–900 gm
Recommended Drug: 0.01 mg/gm ketamine plus 0.001 mg/kg diazepam, IV
Supplemental Drug: 0.005 mg/gm ketamine, IV
Antagonist: None
Alternative Drugs: 0.02 mg/gm ketamine plus 0.002 mg/kg acepromazine
References: Mattingly, 1972; Redig and Duke, 1976; Jessup et al., 1980; Freed and Baker, 1989

OWL, GREAT HORNED, *Bubo virgianus*
Weight: 1.1–1.4 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 25 mg/kg ketamine plus 1.2 mg/kg diazepam, IV
• 20 mg/kg ketamine plus 2 mg/kg acepromazine
References: Mattingly, 1972; Borzio, 1973; Frank and Cooper, 1974; Redig and Duke, 1976; Jessup et al., 1980; Redig et al., 1984; Freed and Baker, 1989; Kreeger et al., 1993

OWL, SCREECH, *Otus asio*
Weight: 150–300 gm
Recommended Drug: 0.01 mg/gm Telazol®
Supplemental Drug: 0.01 mg/gm ketamine
Antagonist: None
Alternative Drugs: 0.02 mg/gm ketamine plus 0.002 mg/gm acepromazine
References: Kittle, 1972; Mattingly, 1972; Borzio, 1973; Beck, 1976; Jessup et al., 1980; Kreeger et al., 1993

OWL, SNOWY, *Nyctea scandiaca*
Weight: 1.8–2.1 kg
Recommended Drug: 18 mg/kg ketamine plus 1.2 mg/kg diazepam, IV
Supplemental Drug: 5 mg/kg ketamine, IV
Antagonist: None
References: Redig and Duke, 1976

OWLS, GENERAL
Recommended Drug: 20 mg/kg ketamine plus 2 mg/kg acepromazine

Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
References: Borzio, 1973; Camburn and Stead, 1978; Amand, 1982a

PACARANA, *Dinomys branickii*
Weight: 10–15 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
References: Schobert, 1987

PADEMELON, RED-LEGGED, *Thylogale stigmatica*
Weight: 2–12 kg
Recommended Drug: 6 mg/kg Telazol®
Supplemental Drug: 6 mg/kg ketamine
Antagonist: None
References: Shima et al., 1993

PANDA, GIANT, *Ailuropoda melanoleuca*
Weight: 75–160 kg
Recommended Drug: 5 mg/kg ketamine plus 0.4 mg/kg xylazine
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None reported
Alternative Drugs: 6.6 mg/kg Telazol®
References: Graham-Jones, 1964; Schaller et al., 1985; Fan et al., 1987; Schobert, 1987; Yu and Yu, 1987; Qiu, 1990; Zhu and Wang, 1992; Mainka and He, 1993

PANDA, LESSER, *Ailurus fulgens*
Weight: 3–6 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 4 mg/kg ketamine plus 0.1 mg/kg medetomidine; antagonize with 0.5 mg/kg atipamezole
• 10 mg/kg ketamine plus 2 mg/kg xylazine
References: Seal et al., 1970; Custer et al., 1978; Schobert, 1987; Jalanka and Roeken, 1990; Chakraborty, 1993

PANGOLIN, *Manis tetradactyla*
Weight: 2–2.5 kg
Recommended Drug: 22 mg/kg ketamine
Supplemental Drug: 11 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970; Robinson, 1983; IWVS, 1992

PARROTS, GENERAL
Recommended Drug: 10 mg/kg ketamine plus 1 mg/kg diazepam
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg Telazol®
References: Beck, 1976; Amand, 1982a; Schobert, 1987

PECCARY, CHACOAN, *Catagonus wagneri*
Weight: 29.5–40 kg
Recommended Drug: 2.2 mg/kg Telazol®
Supplemental Drug: 2.2 mg/kg ketamine
Antagonist: None
References: Allen, 1992b

PECCARY, COLLARED, *Tayassu tajacu*
Weight: 14–30 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 8 mg/kg ketamine plus 10 mg/kg xylazine
References: Kroll, 1962; Dyson, 1965; Jewell et al., 1965; Day, 1969; Seal et al., 1970; Jones, 1972; Gray et al., 1974; Gallagher et al., 1985; Hellgren et al., 1985; Schobert, 1987; Kock et al., 1989

PORCUPINE, CAPE, *Hystrix africaeustralis*
Weight: 12–18 kg
Recommended Drug: 0.16 mg/kg fentanyl plus 0.66 mg/kg xylazine
Supplemental Drug: 0.08 mg/kg fentanyl
Antagonist: 0.2 mg/kg naloxone plus 0.2 mg/kg yohimbine
Alternative Drugs: 5 mg/kg ketamine plus 1.5 mg/kg xylazine
References: Van Aarde, 1985

PORCUPINE, CRESTED, *Hystrix cristata*
Weight: 10–20 kg
Recommended Drug: 10 mg/kg ketamine plus 2 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine only
Antagonist: None reported
Alternative Drugs: 30 mg/kg ketamine plus 0.01 mg/kg promazine
Comments: Porcupines require high doses for complete immobilization. The recommended dose may only heavily sedate the animal and additional ketamine may be required for surgery or other manipulations.
References: Beck, 1976; Stoskopf, 1979; Pigozzi, 1987

PORCUPINE, INDIA CRESTED, *Hystrix indica*
Weight: 10–30 kg

Recommended Drug: 15 mg/kg ketamine plus 1 mg/kg xylazine
Supplemental Drug: 10 mg ketamine
Antagonist: None reported
References: Bose et al., 1982; Alkon, 1984

PORCUPINE, NORTH AMERICAN, *Erethizon dorsatum*
Weight: 3.5–10 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Seal and Erickson, 1969; Seal et al., 1970; Hale et al., 1994

POSSUM, BRUSH-TAIL, *Trichosurus vulpecula*
Weight: 1.3–5 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 50 mg/kg ketamine
References: Denny, 1974; Smeller et al., 1977; Shima et al., 1993

POSSUM, MOUNTAIN PYGMY, *Burramys parvus*
Weight: 30–60 gm
Recommended Drug: 0.007 mg/gm Telazol®
Supplemental Drug: 0.003 mg/gm ketamine
Antagonist: None
References: Holz, 1992

POSSUM, RINGTAIL, *Pseudocheirus peregrinus*
Weight: 0.7–1 kg
Recommended Drug: 7.5 mg/kg Telazol®
Supplemental Drug: 7.5 mg/kg ketamine
Antagonist: None
References: Bush et al., 1990; Holz, 1992

POTOROO, *Potorous spp.*
Weight: 0.5–2.2 kg
Recommended Drug: 9.5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Bush et al., 1990

POTOROO, LONG-NOSED, *Potorous tridactylus*
Weight: 0.7–1.3 kg
Recommended Drug: 15 mg/kg Telazol®
Supplemental Drug: 15 mg/kg ketamine

Antagonist: None
Alternative Drugs: 25 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Alford et al., 1974; Finnie, 1976; Smeller et al., 1977; Ludders and Ojerio, 1980; Schobert, 1987

PRAIRIE DOG, BLACK-TAILED, *Cynomys ludovicianus*
Weight: 0.7–1.5 kg
Recommended Drug: 30 mg/kg ketamine plus 0.5 mg/kg diazepam
Supplemental Drug: 15 mg/kg ketamine only
Antagonist: None
Alternative Drugs: 20 mg/kg Telazol®
References: Roslyn et al., 1979; Stoskopf, 1979

PRONGHORN, *Antilocapra americana*
Weight: 40–50 kg
Recommended Drug: 0.05 mg/kg carfentanil plus 1 mg/kg xylazine
Supplemental Drug: If animal is not down in 20 min, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
Alternative Drugs: 0.1 mg/kg etorphine plus 1 mg/kg xylazine, antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 5 mg/kg ketamine plus 0.3 mg/kg medetomidine; antagonize with 1.5 mg/kg atipamezole
Comments: To reduce renarcotization with carfentanil, give a double dose of the antagonists, one IV and the other IM. Even after antagonism, expect the animal to undergo a period (up to 30 min) of excitement (rapid pacing, tongue hanging out, etc.). Do *not* give xylazine to a pronghorn if you are not going to use an antagonist - prolonged hyperexcitability may ensue. Although etorphine/xylazine can be used on pronghorn, the carfentanil-xylazine combination has provided the best results in my experience. I have also used the ketamine-medetomidine combination with some success on captive (not excited) pronghorn. In general, pronghorn are extraordinarily difficult to immobilize; be prepared for less than satisfactory results.
References: Jarvis and Morris, 1960; Thomas, 1961; Dyson, 1965; Beale and Smith, 1967; Gray et al., 1974; Chalmers and Barrett, 1977; Copeland et al., 1978; Seal and Hoskinson, 1978; Amstrup and Segerstrom, 1981; Autenrieth et al., 1981; Pusateri et al., 1982; Thorne, 1982; Carpenter and Lance, 1983; O'Gara, 1987; Schobert, 1987; Williams and Riedesel, 1987; Pond and O'Gara, 1994

PUKU, *Kobus vardoni*
Weight: 50–90 kg
Recommended Drug: 25 mg fentanyl plus 150 mg azaperone
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 0.2 mg/kg naltrexone or naloxone

References: Hanks and Dowsett, 1969; Haigh, 1976d

PUMA - SEE LION, MOUNTAIN

QUOKKA, *Setonix brachyurus*
Weight: 2–5 kg
Recommended Drug: 8 mg/kg ketamine plus 8 mg/kg xylazine
Supplemental Drug: 4 mg/kg ketamine only
Antagonist: None reported
References: Richardson and Cullen, 1984

RABBIT, COTTONTAIL, *Sylvilagus floridanus*
Weight: 0.8–1.5 kg
Recommended Drug: 44 mg/kg ketamine plus 5 mg/kg xylazine
Supplemental Drug: 22 mg/kg ketamine
Antagonist: None
Alternative Drugs: 44 mg/kg ketamine plus 5 mg/kg acepromazine
• 44 mg/kg ketamine plus 10 mg/kg diazepam
References: Wesson et al., 1977; Garver and Jackson, 1985

RABBIT, *Oryctolagus cuniculus*
Weight: 1.3–2.2 kg
Recommended Drug: 30 mg/kg ketamine plus 6 mg/kg xylazine
Supplemental Drug: 15 mg/kg ketamine
Antagonist: 0.22 mg/kg yohimbine
Alternative Drugs: 44 mg/kg ketamine plus 5 mg/kg acepromazine
• 44 mg/kg ketamine plus 10 mg/kg diazepam
• 22 mg/kg Telazol®
References: Weisbroth and Fudens, 1972; Stunkard and Miller, 1974; Hughes et al., 1975; Kisloff, 1975; White and Holmes, 1976; Garver and Jackson, 1985; Wiesner and von Hegel, 1985; Schobert, 1987; Keller et al., 1988

RACCOON, *Procyon lotor*
Weight: 2–12 kg
Recommended Drug: 20 mg/kg ketamine plus 4 mg/kg xylazine
Supplemental Drug: 10 mg/kg ketamine
Antagonist: 0.15 mg/kg yohimbine
Alternative Drugs: 20 mg/kg ketamine plus 0.1 mg/kg acepromazine
• 12 mg/kg Telazol®
References: Murry and Dennett, 1963; Mech, 1965; Seal and Erickson, 1969; Seal et al., 1970; Bigler and Hoff, 1974; Gray et al., 1974; Haupert and Lindeen, 1974; Gregg and Olson, 1975; Hughes et al., 1975; Speckmann, 1975; Beck, 1976; Ramsden et al., 1976; Boever et al., 1977; Jessup et al., 1980; Hoilien and Oates, 1982; Jessup, 1982b; Wright, 1983; Genevois et al., 1984b; Wiesner and von Hegel, 1985; Clutton and Duggan, 1986; Schobert,

1987; Seal and Kreeger, 1987; Deresienki and Rupprecht, 1989; Servin and Huxley, 1992; Taulman and Williamson, 1993; Norment et al., 1994; Pond and O'Gara, 1994

RAPTORS, GENERAL
Recommended Drug: 5 mg/kg ketamine plus 0.5 mg/kg xylazine IV
Supplemental Drug: 2.5 mg/kg ketamine IV
Antagonist: None
Alternative Drugs: 30 mg/kg ketamine plus 1 mg/kg diazepam IM
References: Haigh, 1980

RAT, NORWAY, *Rattus norvegicus*
Weight: 200–400 gm
Recommended Drug: 0.025 mg/gm Telazol®
Supplemental Drug: 0.025 mg/gm ketamine
Antagonist: None
Alternative Drugs: 0.044 mg/gm ketamine
References: Weisbroth and Fudens, 1972; Hughes et al., 1975; Genevois et al., 1984a; Schobert, 1987

RATEL - SEE BADGER, HONEY

RATITES, GENERAL
Recommended Drug: 40 mg/kg ketamine plus 1 mg/kg diazepam
Supplemental Drug: 20 mg/kg ketamine
Antagonist: None
References: Amand, 1982a

RATS, GENERAL
Weight: 0.2–1 kg
Recommended Drug: 50 mg/kg ketamine
Supplemental Drug: 25 mg/kg ketamine
Antagonist: None
References: Stunkard and Miller, 1974; Mulder and Johnson, 1978; Garver and Jackson, 1985

REEDBUCK, *Redunca arundinum*
Weight: 60–95 kg
Recommended Drug: 2 mg etorphine plus 10 mg xylazine
Supplemental Drug: 1 mg etorphine
Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
Alternative Drugs: 12 mg fentanyl plus 75 mg azaperone
References: Pienaar, 1968a; 1973; Jones, 1972; Röken, 1975; Haigh, 1976d; Hofmeyr, 1981; Flamand and Rogers, 1992; IWVS, 1992; Burroughs, 1993d

REEDBUCK, MOUNTAIN, *Redunca fulvorufula*
Weight: 60–95 kg
Recommended Drug: 2 mg etorphine plus 40 mg azaperone
Supplemental Drug: 1 mg etorphine
Antagonist: 2 mg diprenorphine per mg etorphine given
References: Burroughs, 1993d

REINDEER - SEE CARIBOU

REPTILES, GENERAL
Weight: <50 gm
Recommended Drug: 0.1 mg/gm ketamine
Supplemental Drug: 0.05 mg/gm ketamine
Alternative Drugs: 0.04 mg/gm ketamine plus 0.008 mg/gm xylazine

Weight: 50 gm–1 kg
Recommended Drug: 0.05 mg/gm ketamine
Supplemental Drug: 0.025 mg/gm ketamine
Alternative Drugs: 0.025 mg/gm ketamine plus 0.005 mg/gm xylazine

Weight: 1–20 kg
Recommended Drug: 25 mg/kg ketamine
Supplemental Drug: 12 mg/kg ketamine
Alternative Drugs: 10 mg/kg ketamine plus 2 mg/kg xylazine

Weight: 20–50 kg
Recommended Drug: 12 mg/kg ketamine
Supplemental Drug: 6 mg/kg ketamine
Alternative Drugs: 7.5 mg/kg ketamine plus 1.5 mg/kg xylazine

Weight: 50–100 kg
Recommended Drug: 8 mg/kg ketamine
Supplemental Drug: 4 mg/kg ketamine
Alternative Drugs: 5 mg/kg ketamine plus 1 mg/kg xylazine
Comments: Reptiles should be acclimated to their preferred ambient temperature (30–35 °C/86–95° F) prior to immobilization. Complete behavioral recovery from anesthesia can take *days*. Never assume an anesthetized, venomous reptile is incapable of biting – take appropriate precautions when handling such animals. Alphaxalone/alphadolone has been shown effective in many reptiles (see Lawrence, 1988).
References: Hinsch and Gandal, 1969; Kaplan, 1969; Beck, 1976; Ahmad et al., 1977; Jones, 1977b; Boever, 1979; Sedgwick, 1980b; Jackson et al., 1981; Boever and Caputo, 1982; Genevois et al., 1983a; Lawrence, 1983; Cooper, 1984; 1987; Harper, 1984; Sedgwick, 1986; Adest et al., 1988; Arena et al., 1988; Bennett, 1991; 1993a; 1994; Bienzle and Boyd, 1991; Frye, 1991;

Boyer, 1992; Pietrak, 1992; Avery, 1993a; Hochleithner, 1993; Schildger et al., 1993; Holz and Holz, 1994

RHEA, *Rhea americana*
Weight: 15–25 kg
Recommended Drug: 22 mg/kg Telazol®
Supplemental Drug: 11 mg/kg ketamine
Antagonist: None
References: Beck, 1976; Camburn and Stead, 1978; Schobert, 1987; Matthews, 1993

RHEBOK, GREY, *Pelea capreolus*
Weight: 20–30 kg
Recommended Drug: 0.01 mg/kg etorphine plus 0.4 mg/kg xylazine
Supplemental Drug: 0.005 mg/kg etorphine
Antagonist: 2 mg/kg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
Alternative Drugs: 0.2 mg/kg fentanyl plus 0.4 mg/kg xylazine
• 10 mg fentanyl plus 20 mg azaperone
Comments: Monitor for respiratory depression when using opioids.
References: Van Niekerk et al., 1963a; IWVS, 1992; Burroughs, 1993d

RHINOCEROS, BLACK, *Diceros bicornis*
Weight: 800–1,400 kg
Recommended Drug: 4.5 mg etorphine plus 250 mg azaperone
Supplemental Drug: 2.25 mg etorphine
Antagonist: 2 mg diprenorphine per mg etorphine given
Alternative Drugs: 1 mg etorphine plus 30 mg fentanyl plus 200 mg azaperone; antagonize with 2 mg diprenorphine per mg etorphine given
• 4 mg etorphine plus 100 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given
• 0.0015 mg/kg carfentanil plus 0.15 mg/kg azaperone; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given
Comments: Monitor for respiratory depression (< 4 breaths/min); administer 200 mg doxapram, if necessary. Oxygenation can be improved by giving 10–20 nalorphine or 20-40 nalbuphine IV immediately after induction; this will not cause complete antagonism of etorphine (Kock et al., pers. comm.). Change the animal's position every 20 minutes. If body temperature exceeds 41° C (105.8° F), consider giving the antagonist immediately. Hyaluronidase (4,500 IU) may be added to the drug mixture to hasten induction. For calves (100-500 kg), use 2 mg etorphine plus 75 mg azaperone.
References: Buechner et al., 1960a; 1960c; Harthoorn, 1960; 1962b; 1963a; 1963d; 1965a; 1966; 1972a; 1973a; 1973b; Harthoorn and Lock, 1960; 1961; Larsen, 1963; Condy, 1964; King and Carter, 1965; Ebedes, 1966b; 1967; Jones, 1966; Jones and Roth, 1968; Wallach, 1968; 1969; Denney, 1969; Keep

et al., 1969; King, 1969; Hitchins et al., 1972; Hofmeyr and de Bruine, 1973; Keep, 1973b; 1973c; Alford et al., 1974; De Vos, 1975; Eltringham, 1974; Manton and Jones, 1974; Hofmeyr, 1975; Röken, 1975; Haigh, 1976d; 1977b; Flamand et al., 1984; MacKintosh and Van Reenen, 1984b; Henwood, 1989; Morkel, 1989; Gaynor and Haigh, 1992; Kock et al., 1990a; 1990b; 1990c; Kock, 1991; 1992; IWVS, 1992; Kock and Morkel, 1993; Jessup et al., 1993; Rogers, 1993c

RHINOCEROS, INDIAN, *Rhinoceros unicornis*

Weight: 1,600–2,200 kg
Recommended Drug: 2.25 mg etorphine plus 10 mg acepromazine
Supplemental Drug: 2 mg etorphine
Antagonist: 2 mg diprenorphine per mg etorphine given
References: Alford et al., 1974; Dinerstein et al., 1990

RHINOCEROS, WHITE, *Ceratotherium simum*

Weight: 1,400–1,700 (f), 2,000–3,600 (m) kg
Recommended Drug: 3 mg etorphine plus 12 mg detomidine (f); 4 mg etorphine plus 20 mg detomidine (m)
Supplemental Drug: 1 mg etorphine
Antagonist: 15 mg naltrexone
Alternative Drugs: 0.001 mg/kg carfentanil plus 0.1 mg/kg azaperone; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given
• 1.6 ml Large Animal Immobilon®; antagonize with 2 mg diprenorphine per mg etorphine given
Comments: Use large needles (45–60 mm length, ≥ 2mm diam.) with minimal barb. The needle tip can be bent over the axis of the bore to prevent plugging or side port needles can be used. The dart injection site must be treated with antimicrobial agent to prevent abcesses. Hyaluronidase (1,500-3,000 IU) combined with immobilizing agent can speed induction. Prolonged recumbency may cause respiratory depression. Close monitoring is necessary, particularly if immobilization exceeds 40 minutes. Try to maintain the animal in sternal recumbency. Oxygenation can be improved by giving 10–20 nalorphine or 20-40 nalbuphine IV immediately after induction; this will not cause complete antagonism of etorphine (Kock et al., 1995). Respirations may also be increased by administering 300-400 mg doxapram IV. The white rhino is particularly prone to renarcotization after carfentanil use; if at all possible use naltrexone to antagonize. Complications include hypoxia and hyperthermia. Muscle tremors can be reduced by giving 15 mg diazepam IV. Try to avoid darting at ambient temperatures >25° C (77° F). Cool the animal if body temperature >39° C (102.2° F). If hypoxia is evident, the pulse rate is >120 bpm, and body temperature is >39° C, antagonize the immobilizing agent immediately. If the animal is being transported, it may be beneficial to antagonize the opioid anesthetic with diprenorphine instead of naltrexone because naltrexone can result in a fully alert animal that might fight the crate throughout transport (Rogers, 1993b).

References: Harthoorn, 1962a; 1962b; 1962c; 1963a; 1963d; 1965a; 1967; 1972a; 1973a; 1973b; Harthoorn and Player, 1963; Van Niekerk et al., 1963a; Ebedes, 1966b; Pienaar et al., 1966a; Wallach, 1966; Player, 1967; 1973; Wallach, 1968; 1969; Keep, 1969; 1971; 1972a; 1972b; 1973b; Pienaar, 1969a; York and Huggins, 1972; Alford et al., 1974; Manton and Jones, 1974; De Vos, 1975; Röken, 1975; Smuts, 1975; Haigh, 1976d; Jenkins, 1978; Wiesner et al., 1982; Flamand et al., 1984; LeBlanc et al., 1987; Allen et al., 1991; Heard et al., 1992; IWVS, 1992; Rogers, 1993b; Hattingh et al., 1994c; Kock et al., 1995

RINGTAIL, *Bassariscus astutus*

Weight: 0.8–1.3 kg

Recommended Drug: 10 mg/kg Telazol®

Supplemental Drug: 10 mg/kg ketamine

Antagonist: None

Alternative Drugs: 15 mg/kg ketamine plus 0.2 mg/kg acepromazine

References: Seal and Erickson, 1969; Seal et al., 1970; Gray et al., 1974; Jessup et al., 1980; Jessup, 1982b; Seal and Kreeger, 1987

SABLE, *Hippotragus niger*

Weight: 150–260 kg

Recommended Drug: 6 mg etorphine plus 20 mg xylazine

Supplemental Drug: 3 mg etorphine

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 3 mg/kg Telazol® plus 0.2 mg/kg xylazine; antagonize with 0.15 mg/kg yohimbine

- 3 mg carfentanil plus 50 mg ketamine plus 50 mg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
- 3 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine (calm animals only)

Comments: Prone to hyperthermia because of dark coat. Handle bulls separately to avoid intraspecific aggression. Semi-immobilized animals may be attacked by other sable, particularly from another herd. Restrain horns at all times.

References: Pienaar et al., 1966a; Pienaar, 1968a; 1969b; 1973a; Göltenboth and Klös, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; York and Huggins, 1972; Grobler and Van der Meulen, 1975; Röken, 1975; Smuts, 1975; York, 1975; Haigh, 1976d; Jones, 1977; Slee and Walker, 1977; Hofmeyr, 1981; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Schobert, 1987; Strauss, 1987; Williams and Riedesel, 1987; Henwood and Keep, 1989; Bush et al., 1992; Snyder et al., 1992; Burroughs, 1993d

SAIGA, RUSSIAN, *Saiga tatarica*

Weight: 29–69 kg

Recommended Drug: 2.1 mg carfentanil
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltexone or naloxone per mg carfentanil given
Alternative Drugs: 7.4 mg/kg ketamine plus 4 mg/kg xylazine; antagonize with 1.2 mg/kg tolazoline
Comments: Prone to excessive running during induction with carfentanil. Monitor for hyperthermia and respiratory depression.
References: Jensen, 1982; Strauss, 1987; Allen et al., 1991

SAMBAR, *Cervus unicolor*
Weight: 109–260 kg
Recommended Drug: 2.1 mg carfentanil plus 30 mg xylazine (males); 1.2 mg carfentanil plus 15 mg xylazine (females)
Supplemental Drug: If animal is not down in 20 min, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
Alternative Drugs: 0.7 ml Large Animal Immobilon® plus 30 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 6.6 mg/kg Telazol®
- 10 mg fentanyl plus 80 mg azaperone plus 100 mg xylazine (i.e., Fentaz® plus xylazine); antagonize with 0.2 mg/kg naloxone plus 2 mg/kg tolazoline

References: Rapley and Mehren, 1975; Wiesner, 1975; Nair, 1977; Keep, 1979; Wiesner et al., 1982; Arora et al., 1983; Jones, 1984; Wiesner and von Hegel, 1985; Mac Lentz et al., 1986; Schobert, 1987; Seal and Bush, 1987; Strauss, 1987; Arora, 1988; Van Mourik et al., 1988; Allen et al., 1991; Tung et al., 1993

SAMBAR, PHILLIPINE, *Cervus mariannus*
Weight: 40–60 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 3.3 mg/kg ketamine
Antagonist: None
References: Gray et al., 1974; Schobert, 1987

SAMBAR, SUNDA, *Cervus timorensis*
Weight: 53–73 kg
Recommended Drug: 0.6 mg carfentanil plus 15 mg xylazine
Supplemental Drug: If animal is not down in 20 min, repeat full dose
Antagonist: 100 mg naltexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
Alternative Drugs: 0.05 mg/kg etorphine plus 0.2 mg/kg acepromazine; antagonize with 0.1 mg/kg diprenorphine
References: Jones, 1972; 1978; 1984; Presidente et al., 1978b; Keep, 1979; Van Mourik and Stelmasiak, 1984; Seal and Bush, 1987; Allen et al., 1991

SEA LION, CALIFORNIA, *Zalophus californianus*

Weight: 50–110 (f), 200–400 (m) kg

Recommended Drug: 10 mg/kg ketamine plus 0.22 mg/kg midazolam or diazepam

Supplemental Drug: 5 mg/kg ketamine

Antagonist: None

Alternative Drugs: 4 mg/kg ketamine plus 0.5 mg/kg xylazine

• 1.7 mg/kg Telazol®; do not give supplemental dose of Telazol®

Comments: 0.02 mg/kg atropine may be added to the recommended dose to decrease secretions. For long procedures, you may wish to intubate the animal and use gas anesthesia. Halothane alone can be used to induce and anesthetize medium-sized females and pups using only physical restraint and a portable anesthesia machine (see Work et al., 1992; 1993). If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Heuschele, 1961a; 1961b; Kroll, 1962; Ericksen, 1968; Ridgway and Simpson, 1969; Geraci, 1973; Beck, 1976; Gray et al., 1974; McGrath et al., 1979; Trillmich and Wiesner, 1979; Trillmich, 1983; Gage, 1984; 1993; Joseph and Cornell, 1988; Gales, 1989; Williams et al., 1990a; Work et al., 1992; 1993; Heard and Beusse, 1993; Heath et al., 1994

SEA LION, NORTHERN (STELLER), *Eumetopias jubatus*

Weight: 270 (f), 1,000 (m) kg

Recommended Drug: 2.1 mg/kg ketamine

Supplemental Drug: 1 mg/kg ketamine

Antagonist: None

Alternative Drugs: 2 mg/kg Telazol®; do not give supplemental dose of Telazol®

Comments: 0.02 mg/kg atropine may be added to the recommended dose to decrease secretions. For extended immobilization times, induce with Telazol® then maintain on gas anesthesia. If induction with Telazol® is rapid (< 6 min), be prepared to stimulate respiration either chemically or manually.

References: Loughlin and Spraker, 1989; Gage, 1993; Heath et al., 1994; 1996

SEA LION, SOUTHERN, *Otaria flavescens*

Weight: 140 (f), 200–350 (m) kg

Recommended Drug: 2 mg/kg Telazol®

Supplemental Drug: 1 mg/kg ketamine

Antagonist: None

Comments: Monitor closely for hyperthermia, particularly when ambient temperature >20° C (68° F). If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Cárdenas and Cattan, 1986; IWVS, 1992

SEAL, ANTARCTIC FUR, *Arctocephalus gazella*

Weight: 30–51 (f), 126–160 (m) kg

Recommended Drug: 5 mg/kg ketamine plus 1 mg/kg xylazine

Supplemental Drug: 2.5 mg/kg ketamine

Antagonist: None reported

Alternative Drugs: 1.7 mg/kg Telazol®; do not give supplemental dose of Telazol®

Comments: 0.02 mg/kg atropine may be added to the recommended dose to decrease secretions. For long procedures, you may wish to intubate the animal and use gas anesthesia. If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Bester, 1988; Gales, 1989; Boyd et al., 1990; Williams et al., 1990a; Gage, 1993

SEAL, CRABEATER, *Lobodon carcinophagus*

Weight: 200–300 kg

Recommended Drug: 6 mg/kg ketamine plus 0.2 mg/kg diazepam

Supplemental Drug: 3 mg/kg ketamine

Antagonist: None

Comments: If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Cline et al., 1969; Vergani et al., 1986; Gales, 1989; Williams et al., 1990a; Shaughnessy, 1991; Gage, 1993

SEAL, GALAPAGOS FUR, *Arctocephalus galapagoensis*

Weight: 27 (f), 64 (m) kg

Recommended Drug: 4 mg/kg ketamine plus 0.5 mg/kg xylazine

Supplemental Drug: 2 mg/kg ketamine

Antagonist: None reported

Alternative Drugs: 1.7 mg/kg Telazol®; do not give supplemental dose of Telazol®

- 4.5 mg/kg ketamine plus 0.14 mg/kg diazepam

Comments: 0.02 mg/kg atropine may be added to the recommended dose to decrease secretions. Monitor continually for hyperthermia. The ketamine/diazepam dose may be given intravenously in restrained seals for a more rapid induction. For long procedures, you may wish to intubate the animal and use gas anesthesia. If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Trillmich, 1983; Cardenas and Cattan, 1986; Gales, 1989; Gage, 1993

SEAL, GRAY, *Halichoerus grypus*

Weight: 105–186 (f), 170–310 (m) kg

Recommended Drug: 1 mg/kg Telazol®

Supplemental Drug: 0.5 mg/kg ketamine only

Antagonist: None

Alternative Drugs: 4 mg/kg ketamine plus 0.75 mg/kg xylazine

• 6 mg/kg ketamine plus 0.2 mg/kg diazepam

Comments: Use needles over 60 mm long to penetrate blubber layer. Opioids are not recommended because they can cause prolonged apnea which must be antagonized to avoid death. If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Jewell and Smith, 1965; Parry et al., 1981; Geraci et al., 1981; Baker and Gatesman, 1985; Baker et al., 1988; 1990; Gales, 1989; Williams et al., 1990a; Gage, 1993

SEAL, GUADALUPE FUR, *Arctocephalus phillipi*

Weight: 50 (f), 140 (m) kg

Recommended Drug: 3.6 mg/kg ketamine plus 0.12 mg/kg diazepam

Supplemental Drug: 1.8 mg/kg ketamine

Antagonist: None

Comments: The recommended drug combination may be given IV, but the dose should be reduced by 50% and heart rate and core body temperature should be monitored throughout immobilization.

References: Cardenas and Cattan, 1986; Sepúlveda et al., 1994

SEAL, HARBOR (COMMON), *Phoca vitulina*

Weight: 50–150 (f), 70–170 (m) kg

Recommended Drug: 1.5 mg/kg Telazol®

Supplemental Drug: 1 mg/kg ketamine

Antagonist: None

Alternative Drugs: 1.5 mg/kg ketamine plus 0.05 mg/kg diazepam

Comments: 0.02 mg/kg atropine may be added to the recommended dose to decrease secretions. For long procedures, you may wish to intubate the animal and use gas anesthesia. If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Finer, 1954; Kroll, 1962; Geraci, 1973; Hammond and Elsner, 1977; Geraci et al., 1981; Sinnett et al., 1981; Gage, 1984; 1993; Joseph and Cornell, 1988; Gales, 1989; Williams et al., 1990a

SEAL, HARP, *Phoca groenlandica*

Weight: 120–135 kg

Recommended Drug: 6 mg/kg ketamine plus 0.2 mg/kg diazepam

Supplemental Drug: 3 mg/kg ketamine

Antagonist: None
Comments: If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.
References: McDonell, 1972; Beck, 1976; Engelhardt, 1977; Gales, 1989; Williams et al., 1990a; Gage, 1993

SEAL, HOODED, *Cystophora cristata*
Weight: 145–300 (f), 200–400 (m) kg
Recommended Drug: 6 mg/kg ketamine plus 0.2 mg/kg diazepam
Supplemental Drug: 3 mg/kg ketamine
Antagonist: None
Comments: If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.
References: Haigh and Stewart, 1979; Gales, 1989; Williams et al., 1990a; Gage, 1993

SEAL, LEOPARD, *Hydrurga leptonyx*
Weight: 500 (f), 270 (m) kg
Recommended Drug: 8 mg/kg ketamine plus 0.22 mg/kg midazolam or diazepam
Supplemental Drug: 4 mg/kg ketamine
Antagonist: None
Comments: 0.02 mg/kg atropine may be added to the recommended dose to decrease secretions. If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.
References: Gales, 1984; 1989; Williams et al., 1990a; Mitchell and Burton, 1991; Gage, 1993

SEAL, NORTHERN ELEPHANT, *Mirounga angustirostris*
Weight: 900 (f), 2,000–2,700 (m) kg
Recommended Drug: 10 mg/kg ketamine plus 0.22 mg/kg midazolam or diazepam
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 2.2 mg/kg Telazol®
Comments: If using ketamine/diazepam, give diazepam separately. 0.02 mg/kg atropine may be added to the recommended dose to decrease secretions.
References: Kroll, 1962; Ericksen, 1968; Cline et al., 1969; Gray et al., 1974; Briggs et al., 1975; Cornell, 1977; Hammond and Elsner, 1977; Gage, 1984; Sedgwick, 1986; Schobert, 1987; Joseph and Cornell, 1988; Gales, 1989

SEAL, NORTHERN FUR, *Callorhinus ursinus*

Weight: 43–50 (f), 181–272 (m) kg

Recommended Drug: 1.2 mg/kg Telazol®

Supplemental Drug: 1 mg/kg ketamine

Antagonist: None

Alternative Drugs: 7 mg/kg ketamine plus 0.22 mg/kg diazepam

Comments: If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Kroll, 1962; Peterson, 1965; Keyes, 1965; Gage, 1984; Gales, 1989; Kiyota et al., 1992

SEAL, RINGED, *Phoca hispida*

Weight: 61–142 kg

Recommended Drug: 5 mg/kg ketamine

Supplemental Drug: 2.5 mg/kg ketamine

Antagonist: None

Comments: If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.

References: Geraci, 1973; Geraci et al., 1981; Gales, 1989; Williams et al., 1990a

SEAL, SOUTHERN ELEPHANT, *Mirounga leonina*

Weight: 359–900 (f), 2,000–3,700 (m) kg

Recommended Drug: 1 mg/kg Telazol®

Supplemental Drug: 0.5 mg/kg ketamine

Antagonist: None

Alternative Drugs: 5 mg/kg ketamine plus 1 mg/kg xylazine

- 6 mg/kg ketamine plus 0.3 mg/kg diazepam

Comments: If seal becomes anoxic give doxapram IV.

References: Ling and Nicholls, 1963; Ling et al., 1967; Cline et al., 1969; Ross and Saayman, 1970; Cornell, 1977; Hammond and Elsner, 1977; Ryding, 1982; Gales and Burton, 1987; Bester, 1988; Baker et al., 1988; 1990; Gales, 1989; Woods et al., 1989; Williams et al., 1990a; Mitchell and Burton, 1991; Gage, 1993; Woods et al., 1994

SEAL, SOUTHERN (SOUTH AFRICAN) FUR, *Arctocephalus pusillus*

Weight: 36–122 (f), 134–363 (m) kg

Recommended Drug: 10 mg/kg ketamine plus 0.22 mg/kg midazolam or diazepam

Supplemental Drug: 5 mg/kg ketamine

Antagonist: None

Alternative Drugs: 1.7 mg/kg Telazol®; do not give supplemental dose of Telazol®

Comments: David et al. (1988) found no chemical immobilization suitable for the South African subspecies.
References: Thurman et al., 1982; Gage, 1984; 1993; David et al., 1988

SEAL, WEDDELL, *Leptonychotes weddelli*
Weight: 400–450 kg
Recommended Drug: 3 mg/kg ketamine plus 1 mg/kg xylazine
Supplemental Drug: 1 mg/kg ketamine plus 0.2 mg/kg xylazine
Antagonist: 0.2 mg/kg yohimbine
Alternative Drugs: 1 mg/kg Telazol®
Comments: Maintain anesthetized animals in lateral, as opposed to sternal, recumbency to assist respiration. If seal becomes anoxic due to prolonged apnea, intubate with cuffed endotracheal tube and manually ventilate; doxapram IV may also be given.
References: Flyger et al., 1965; Cline et al., 1969; Beck, 1972; 1976; Hammond and Elsner, 1977; Gales and Burton, 1988; Gales, 1989; Williams et al., 1990a; Phelan and Green, 1992; Bornemann and Plötz, 1993; Gage, 1993

SERVAL, *Felis serval*
Weight: 8.7–18 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine plus 0.2 mg/kg acepromazine
Comments: Darting free-ranging serval is not recommended because they are lost easily before the drug takes effect; trapping is recommended (McKenzie and Burroughs, 1993).
References: Seal et al., 1970; Gray et al., 1974; Hime, 1974; Beck, 1976; Rowe-Rowe and Lowry, 1982; Genevois et al., 1984b; Wiesner and von Hegel, 1985; Schobert, 1987; McKenzie and Burroughs, 1993

SHARKS, GENERAL
Weight: 10–180 kg
Recommended Drug: 20 mg/kg ketamine plus 10 mg/kg xylazine
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None reported
Comments: Carfentanil or Telazol® were found unsuitable in four species of sharks.
References: Gilbert and Wood, 1957; Stoskopf, 1986; 1993

SHEEP, BARBARY - SEE AOUDAD

SHEEP, BIGHORN, *Ovis canadensis*

Weight: 65–150 kg

Recommended Drug: 0.044 mg/kg carfentanil plus 0.2 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 min, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 4.5 mg etorphine plus 50 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Comments: Bighorn sheep are very susceptible to capture myopathy and hyperthermia; careful monitoring of the animal is required. Sheep can be sensitive to xylazine; monitor carefully and always give an antagonist.

References: Franzmann and Thorne, 1970; Thorne, 1971; Alford et al., 1974; Gray et al., 1974; Stelfox and Robertson, 1976; Matthews, 1977; Winegardner et al., 1977; Jessup et al., 1980; 1982b; 1982c; 1984; 1985a; 1985b; 1988; De Vos and Remington, 1981; Thorne, 1982; Andryk et al., 1983; Carpenter and Lance, 1983; Bates et al., 1985; Festa-Bianchet and Jorgenson, 1985; Kock et al., 1987a; 1987b; 1987c; Schobert, 1987; Williams and Riedesel, 1987; Jorgenson et al., 1990; Jessup, 1992a; Pond and O'Gara, 1994

SIAMANG, *Hylobates syndactylus*

Weight: 8–13 kg

Recommended Drug: 10 mg/kg ketamine

Supplemental Drug: 5 mg/kg ketamine

Antagonist: None

References: Beck, 1972; 1976; Beck and Dresner, 1972

SITATUNGA, *Tragelaphus spekei*

Weight: 50–125 kg

Recommended Drug: 6.6 mg/kg ketamine plus 1.1 mg/kg xylazine

Supplemental Drug: 3.3 mg/kg ketamine

Antagonist: 0.125 mg/kg yohimbine

Alternative Drugs: 0.9 mg carfentanil; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given

- 10 mg/kg Telazol®
- 5 mg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
- 5 mg/kg ketamine plus 1 mg/kg xylazine
- 3 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine (calm animals only)

Comments: Xylazine may produce rapid shallow respiration which may be improved by administration of doxapram (Densmore, 1979).

References: Hime and Jones, 1970; Göltenboth and Klös, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; York and Huggins, 1972; Boever and Paluch, 1974; Mehren and Rapley, 1975; Rapley and Mehren, 1975; Röken, 1975; Densmore, 1979; Jensen, 1982; Göltenboth and Klös, 1987; Schobert, 1987; Kock et al., 1989; Allen et al., 1991

SKUNK, HOG-NOSED, *Conepatus leuconotus*
Weight: 2.3–4.5 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Dyson, 1965; Seal and Erickson, 1969; Seal et al., 1970; Seal and Kreeger, 1987

SKUNK, HOODED, *Mephitis macroura*
Weight: 0.7–2.5 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970; Seal and Kreeger, 1987

SKUNK, SPOTTED, *Spilogale spp.*
Weight: 0.2–1 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Seal and Erickson, 1969; Seal et al., 1970; Beck, 1976; Jessup et al., 1980; Jessup, 1982b; Seal and Kreeger, 1987; Pond and O'Gara, 1994

SKUNK, STRIPED, *Mephitis mephitis*
Weight: 2–3 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine plus 0.2 mg/kg acepromazine
References: Verts, 1960; Seal and Erickson, 1969; Seal et al., 1970; Beck, 1972; 1976; Gray et al., 1974; Haupert and Lindeen, 1974; Ramsden et al., 1976; Boever et al., 1977; Jessup et al., 1980; Hoilien and Oates, 1982; Jessup, 1982b; Rosatte and Hobson, 1983; Wright, 1983; Genevois et al., 1984b Schobert, 1987; Seal and Kreeger, 1987; Servin and Huxley, 1992; Pond and O'Gara, 1994

SLOTH, TWO-TOED, *Choloepus hoffmanni*
Weight: 4–8.5 kg
Recommended Drug: 4.4 mg/kg Telazol®
Supplemental Drug: 4.4 mg/kg ketamine
Antagonist: None

Comments: Avoid hypothermia
References: Seal and Erickson, 1969; Seal et al., 1970; Schobert, 1987

SNAKES, GENERAL
Recommended Drug: 75 mg/kg ketamine
Supplemental Drug: 35 mg/kg ketamine
Antagonist: None
Alternative Drugs: 20 mg/kg Telazol®
Comments: Neither drug dose is completely satisfactory for snakes because they induce catalepsy. Expect prolonged recoveries.
References: Brazenor and Kaye, 1953; Karlstrom and Cook, 1955; Mosby and Cantner, 1956; Betz, 1962; Hackenbrock and Finster, 1963; Kraner et al., 1965; Gandal, 1968; Stemmler and Zingg, 1969; Burke and Wall, 1970; Jackson, 1970; Wallach and Hoessle, 1970; Calderwood, 1971; Beck, 1972; 1976; Glenn et al., 1972a; 1972b; Cooper, 1974; Gray et al., 1974; Stunkard and Miller, 1974; Hatori et al., 1975; Beck, 1976; Jones, 1977b; Wang et al., 1977; Calderwood and Jacobson, 1979; Jessup et al., 1980; Sedgwick, 1980b; Strond and Baxter, 1980; Amand, 1982b; Boever and Caputo, 1982; Gillingham et al., 1983; Mulder and Hauser, 1984; Garver and Jackson, 1985; Aird, 1986; Morris, 1986; Schobert, 1987; Johnson, 1991; Schumacher et al., 1992; Page, 1993; Nichols and Lamirande, 1994

SPRINGBOK, *Antidorcas marsupialis*
Weight: 30–48 kg
Recommended Drug: 9 mg/kg ketamine plus 0.5 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine only
Antagonist: 0.125 mg/kg yohimbine
Alternative Drugs: 0.03 mg/kg carfentanil; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given
- 10.6 mg/kg Telazol®
- 1.2 mg etorphine plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Comments: Haloperidol is an effective springbok sedative, lasting 10-12 hr (0.25 mg/kg IM or IV).
References: Heuschele, 1961a; Ebedes, 1962; Van Niekerk et al., 1963a; Bigalke, 1965; Pienaar, 1969b; 1973a; Gauckler and Kraus, 1970; Bauditz, 1972; Heck and Rivenburg, 1972; De Vos, 1975; Rapley and Mehren, 1975; Röken, 1975; York, 1975; Haigh, 1976d; Hofmeyr et al., 1977; Wiesner et al., 1982; 1984; 1985; Jacobson, 1983; Jacobson and Kollias, 1984; Schobert, 1987; IWVS, 1992; Burroughs, 1993d

SQUIRREL, BROWN, *Sciurus vulgaris*
Weight: 200–800 gm
Recommended Drug: 0.005 mg/gm ketamine plus 0.0001 mg/gm medetomidine

Supplemental Drug: 0.003 mg/gm ketamine
Antagonist: 0.0005 mg/gm atipamezole; give 1/2 dose IV, 1/2 IM
Comments: Ketamine-medetomidine may not induce complete immobilization; increase ketamine, if necessary
References: Jalanka and Roeken, 1990

SQUIRREL, AFRICAN GROUND, *Xerus inauris*
Weight: 375–800 gm
Recommended Drug: 0.080 mg/gm ketamine
Supplemental Drug: 0.040 mg/gm ketamine
Antagonist: None
References: Van Heerden, 1984; Van Heerden and Dauth, 1985

SQUIRREL, FLYING (NEW WORLD), *Glaucomys volans*
Weight: 50–185 gm
Recommended Drug: 0.005 mg/gm Telazol®
Supplemental Drug: 0.005 mg/gm ketamine
Antagonist: None
References: IWVS, 1992

SQUIRREL, FOX, *Sciurus niger*
Weight: 300–800 gm
Recommended Drug: 0.012 mg/gm Telazol®
Supplemental Drug: 0.012 mg/gm ketamine
Antagonist: None
References: IWVS, 1992

SQUIRREL, GRAY, *Sciurius carolinensis*
Weight: 300–700 gm
Recommended Drug: 0.0066 mg/gm Telazol®
Supplemental Drug: 0.0066 mg/gm ketamine
Antagonist: None
References: Murry and Dennett, 1963; Seal and Erickson, 1969; Seal et al., 1970; Barry, 1972; Beck, 1976; Moller, 1983; Schobert, 1987

SQUIRREL, RED, *Tamiasciurus hudsonicus*
Weight: 141–312 gm
Recommended Drug: 0.02 mg/gm ketamine plus 0.001 mg/gm xylazine
Supplemental Drug: 0.01 mg/gm ketamine
Antagonist: None reported
Alternative Drugs: Gas anesthesia such as isoflurane
References: Moller, 1983; Seal and Kreeger, 1987

SQUIRREL, RICHARDSON'S GROUND, *Spermophilus richardsonii*
Weight: 290–345 gm

Recommended Drug: 0.085 mg/gm ketamine plus 0.01 mg/gm xylazine
Supplemental Drug: 0.04 mg/gm ketamine
Antagonist: None reported
References: Love, 1970; Genevois et al., 1984a; Olson and McCabe, 1986

SQUIRREL, TRICOLORED, *Callosciurus erythraeus*
Weight: 150–500 gm
Recommended Drug: 0.012 mg/gm Telazol®
Supplemental Drug: 0.012 mg/gm ketamine
Antagonist: None
References: Gray et al., 1974; Schobert, 1987

STEENBOK, *Raphicerus campestris*
Weight: 7–16 kg
Recommended Drug: 0.2 mg/kg fentanyl plus 0.4 mg/kg xylazine
Supplemental Drug: 0.1 mg/kg fentanyl
Antagonist: 0.2 mg/kg naloxone plus 0.15 mg/kg yohimbine
Alternative Drugs: 15 mg/kg Telazol®
• 0.04 mg/kg etorphine plus 0.4 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.15 mg/kg yohimbine
• 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
Comments: Monitor for respiratory depression when using opioids.
References: Van Niekerk et al., 1963a; De Vos, 1975; Smuts, 1975; Wiesner, 1975; 1977; Hofmeyr, 1981; IWVS, 1992; Burroughs, 1993d

STOAT - SEE ERMINE

SUNI, *Neotragus moschatus*
Weight: 4–9 kg
Recommended Drug: 3 mg fentanyl plus 5 mg azaperone
Supplemental Drug: 1.5 mg fentanyl
Antagonist: 0.2 mg/kg naloxone
Alternative Drugs: 10 mg/kg Telazol®
• 0.2 mg/kg fentanyl plus 0.4 mg/kg xylazine
• 0.01 mg/kg etorphine plus 0.4 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: Monitor for respiratory depression when using opioids.
References: Flamand and Lawson, 1986; Schobert, 1987; IWVS, 1992; Burroughs, 1993d

SWAN, BLACK, *Cygnus atratus*
Weight: 5.1–6.3 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 6.6 mg/kg ketamine

Antagonist: None
Alternative Drugs: 60 mg/kg ketamine
References: Beck, 1976; Schobert, 1987

SWAN, BLACK-NECKED, *Cygnus melanocoryphus*
Weight: 4–5.4 kg
Recommended Drug: 6.6 mg/kg Telazol®
Supplemental Drug: 6.6 mg/kg ketamine
Antagonist: None
References: Schobert, 1987

TAHR, *Hemitragus jemlahicus*
Weight: 50–100 kg
Recommended Drug: 1.5 mg/kg ketamine plus 0.09 mg/kg medetomidine
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 0.45 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.001 mg/kg carfentanil plus 0.01 mg/kg xylazine; antagonize with 100 mg naltexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
• 0.8 ml Large Animal Immobilon® plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given
• 4.4 mg/kg Telazol®
References: Jarvis and Morris, 1960; Heck and Rivenburg, 1972; Gray et al., 1974; Rapley and Mehren, 1975; Wiesner, 1975; 1977; Wiesner et al., 1982; 1984; Göltenboth and Klös, 1987; Schobert, 1987; Jalanka and Roeken, 1990; Allen et al., 1991

TALAPOIN, *Miopithecus talapoin*
Weight: 0.75–1.25 kg
Recommended Drug: 12 mg/kg ketamine
Supplemental Drug: 6 mg/kg ketamine
Antagonist: None
References: Beck, 1972; 1976; Beck and Dresner, 1972; Jessup et al., 1980

TAMARAW, *Bubalus mindorensis*
Weight: 700–1,200 kg
Recommended Drug: 0.02 mg/kg etorphine plus 0.1 mg/kg acepromazine
Supplemental Drug: 0.01 mg/kg etorphine
Antagonist: 2 mg diprenorphine per mg etorphine given
References: Roth and Montemayor-Taca, 1971; Masangkay et al., 1993

TAMARIN, COTTON-HEADED, *Saguinus oedipus*
Weight: 225–900 gm
Recommended Drug: 0.005 mg/gm ketamine plus 0.0001 mg/gm medetomidine

Supplemental Drug: 0.003 mg/gm ketamine
Antagonist: 0.0005 mg/gm atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.0022 mg/gm Telazol®
References: Kroll, 1962; Schobert, 1987; Jalanka and Roeken, 1990

TAMARIN, EMPEROR, *Saguinus imperator*
Weight: 225–900 gm
Recommended Drug: 0.005 mg/gm ketamine plus 0.0001 mg/gm medetomidine
Supplemental Drug: 0.003 mg/gm ketamine
Antagonist: 0.0005 mg/gm atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.0022 mg/gm Telazol®
References: Jalanka and Roeken, 1990

TAMARIN, GOLDEN LION, *Leontopithecus rosalia*
Weight: 600–800 gm
Recommended Drug: 0.005 mg/gm ketamine plus 0.0001 mg/gm medetomidine
Supplemental Drug: 0.003 mg/gm ketamine
Antagonist: 0.0005 mg/gm atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.0022 mg/gm Telazol®
References: Heuschele, 1961a; 1961b

TAMARIN, RED-BELLIED, *Saguinus labiatus*
Weight: 225–900 gm
Recommended Drug: 0.005 mg/gm ketamine plus 0.0001 mg/gm medetomidine
Supplemental Drug: 0.003 mg/gm ketamine
Antagonist: 0.0005 mg/gm atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.0022 mg/gm Telazol®
References: Jalanka and Roeken, 1990

TAMARIN, WHITE-LIPPED, *Saguinus nigricollis*
Weight: 225–900 gm
Recommended Drug: 0.0088 mg/gm Telazol®
Supplemental Drug: 0.0088 mg/gm ketamine
Antagonist: None
References: Gray et al., 1974

TAPIR, MALAYAN, *Tapirus indicus*
Weight: 180–320 kg
Recommended Drug: 0.5 ml Large Animal Immobilon® plus 10 mg xylazine
Supplemental Drug: 0.25 ml Large Animal Immobilon®
Antagonist: 2 mg diprenorphine per mg etorphine given
References: Alford et al., 1974; Williams, 1979; Wiesner et al., 1982

TAPIR, SOUTH AMERICAN, *Tapirus terrestris*
Weight: 180–320 kg
Recommended Drug: 2.8 mg/kg Telazol®
Supplemental Drug: 1.4 mg/kg ketamine
Antagonist: None
Alternative Drugs: 1.2 mg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
• 1.3 mg/kg xylazine
References: Kroll, 1962; Heck and Rivenburg, 1972; Alford et al., 1974; Gray et al., 1974; Hertzog, 1975; Mehren and Rapley, 1975; Rapley and Mehren, 1975; Hugues et al., 1986; Schobert, 1987

TAYRA, *Eira barbara*
Weight: 4–5 kg
Recommended Drug: 3.3 mg/kg Telazol®
Supplemental Drug: 3.3 mg/kg ketamine
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine
References: Seal et al., 1970; Beck, 1976; Schobert, 1987

TEAL, BLUE WING, *Anas discors*
Weight: 330–360 gm
Recommended Drug: 0.025 mg/gm Telazol®
Supplemental Drug: 0.025 mg/gm ketamine
Antagonist: None
References: Crider et al., 1968; Crider and McDaniel, 1968; Gray et al., 1974; Schobert, 1987

TEAL, GREEN WING, *Anas crecca*
Weight: 300–400 gm
Recommended Drug: 0.025 mg/gm Telazol®
Supplemental Drug: 0.025 mg/gm ketamine
Antagonist: None
References: Crider et al., 1968; Schobert, 1987

TIGER, *Panthera tigris*
Weight: 100–160 (f), 140–300 (m) kg
Recommended Drug: 3 mg/kg ketamine plus 0.07 mg/kg medetomidine
Supplemental Drug: 1.5 mg/kg ketamine
Antagonist: 0.35 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 4 mg/kg ketamine plus 2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
• 4 mg/kg Telazol®
Comments: Telazol® has caused several adverse reactions in tigers and should be used only when other drugs are unavailable.

References: Pistey and Wright, 1959; Jarvis and Morris, 1960; Heuschele, 1961a; Larsen, 1963; Ericksen, 1968; Seal and Erickson, 1969; Göltenboth and Klös, 1970; Seal et al., 1970; 1987; Bennet et al., 1971; Bauditz, 1972; Foster, 1974; Gray et al., 1974; Hime, 1974; Johnston, 1974; Seidensticker et al., 1974; Beck, 1976; Robinson, 1976; Kuntze, 1977; Wiesner, 1977; Chakrabarti, 1980; Arora et al., 1983; Genevois et al., 1984b; Smith et al., 1983; Wiesner and von Hegel, 1985; Gonzales and McDonnel, 1986; Hugues et al., 1986; Göltenboth and Klös, 1987; Röken, 1987; Schobert, 1987; Kock et al., 1989; Barnett and Lewis, 1990; Jalanka and Roeken, 1990

TITI - SEE MARMOSET, SHORT-TUSKED

TOPI, *Damaliscus lunatus*

Weight: 120–140 kg

Recommended Drug: 4 mg etorphine plus 20 mg xylazine

Supplemental Drug: 2 mg etorphine

Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

Alternative Drugs: 0.001 mg/kg carfentanil plus 0.1 mg/kg xylazine; antagonize with 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Comments: Susceptible to capture myopathy.

References: Talbot and Lamprey, 1961; Talbot and Talbot, 1962; Buck et al., 1963; Pienaar et al., 1966a; Pienaar, 1968a; 1969b; Patrick, 1971; Jones, 1972; De Vos, 1975; 1978a; York and Huggins, 1972; Röken, 1975; Smuts, 1975; York, 1975; Haigh, 1976d; Hofmeyr, 1981; Kock et al., 1989; IWVS, 1992; Burroughs, 1993d

TSESSEBE- SEE TOPI

TUAN - SEE MOUSE, BRUSH-TAILED MARSUPIAL

TURKEY, WILD, *Meleagris gallopavao*

Weight: 4–8 kg

Recommended Drug: Alpha-choralose given orally at a rate of 8 gm/liter cracked corn

Antagonist: None

Comments: Oral administration of immobilizing drugs is generally an ineffective method of capturing birds, but may be employed when no other alternatives exist. Be prepared for extreme variability of effects, ranging from little or no sedation to relatively high mortality.

References: Mosby and Cantner, 1956; Murry and Dennett, 1963; Williams, 1966; 1967; Williams et al., 1966; 1973a; 1973b; Bailey, 1972; Bailey and Doepker, 1977; Evans and Goertz, 1975; Donahue et al., 1982; Holbrook and Vaughan, 1985

TURTLE, BLANDINGS, *Chlemts blandingii*
Weight: 0.5–1.1 kg
Recommended Drug: 50 mg/kg Telazol®
Supplemental Drug: 25 mg/kg Telazol®
Antagonist: None
Alternative Drugs: 15 mg/kg ketamine
Comments: Placing turtles/tortoises in dorsal recumbency (on their "backs") may result in respiratory depression because the viscera will compress the lungs. Surgical anesthesia is achieved when the head is not retracted when pulled out, but the corneal reflex is still present.
References: Beck, 1972; Jessup et al., 1980

TURTLE, LARGE SIDE NECK, *Phrynops geoffroanus*
Weight: 0.8–2 kg
Recommended Drug: 7 mg/kg Telazol®
Supplemental Drug: 7 mg/kg ketamine
Antagonist: None
Comments: Placing turtles/tortoises in dorsal recumbency (on their "backs") may result in respiratory depression because the viscera will compress the lungs. Surgical anesthesia is achieved when the head is not retracted when pulled out, but the corneal reflex is still present.
References: Gray et al., 1974; Schobert, 1987

TURTLE, RED EAR, *Chysemys scripta*
Weight: 0.7–1.5 kg
Recommended Drug: 14 mg/kg Telazol®
Supplemental Drug: 14 mg/kg ketamine
Antagonist: None
Comments: Placing turtles/tortoises in dorsal recumbency (on their "backs") may result in respiratory depression because the viscera will compress the lungs.
References: Wallach and Hoessle, 1970; Gray et al., 1974; Schobert, 1987; Oppenheim and Moon, 1995

TURTLE, SNAPPING, *Chelydra serpentina*
Weight: 5–30 kg
Recommended Drug: 40 mg/kg ketamine plus 2 mg/kg midazolam
Supplemental Drug: 20 mg/kg ketamine
Antagonist: None
Comments: Placing turtles/tortoises in dorsal recumbency (on their "backs") may result in respiratory depression because the viscera will compress the lungs. Surgical anesthesia is achieved when the head is not retracted when pulled out, but the corneal reflex is still present.
References: Mosby and Cantner, 1956; Beck, 1972; Jessup et al., 1980; Bienzle et al., 1991; Bienzle and Boyd, 1992

TURTLE, WOOD, *Clemmys inculpta*
Weight: 0.5–1.1 kg
Recommended Drug: 10 mg/kg Telazol®
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Comments: Placing turtles/tortoises in dorsal recumbency (on their "backs") may result in respiratory depression because the viscera will compress the lungs. Surgical anesthesia is achieved when the head is not retracted when pulled out, but the corneal reflex is still present.
References: Gray et al., 1974; Schobert, 1987

TURTLES/TORTOISES: GENERAL
Recommended Drug: 88 mg/kg ketamine
Supplemental Drug: 44 mg/kg ketamine
Antagonist: None
Alternative Drugs: 22 mg/kg Telazol®
Comments: Placing turtles/tortoises in dorsal recumbency (on their "backs") may result in respiratory depression because the viscera will compress the lungs. Surgical anesthesia is achieved when the head is not retracted when pulled out, but the corneal reflex is still present.
References: Kaplan and Taylor, 1957; Young and Kaplan, 1960; Hunt, 1964; Wallach and Hoessle, 1970; Calderwood, 1971; Kuehn, 1974; Beck, 1976; Calderwood and Jacobson, 1979; Boever and Caputo, 1982; Wood et al., 1982; Garver and Jackson, 1985; Brannian et al., 1987; Schobert, 1987; Adest et al., 1988; Gyuris and Limpus, 1989; Bennett, 1991; Page, 1993; Oppenheim and Moon, 1995; Moon and Stabenau, 1996

UAKARI, *Cacajao spp.*
Weight: 5–10 kg
Recommended Drug: 3.2 mg/kg Telazol®
Supplemental Drug: 3.2 mg/kg ketamine
Antagonist: None
Alternative Drugs: 10 mg/kg ketamine
References: Beck, 1976; Bush et al., 1977; Schobert, 1987

URIAL, *Ovis vignei*
Weight: 50–100 kg
Recommended Drug: 1.2 mg carfentanil (males); 1 mg carfentanil (females)
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltexone or naloxone per mg carfentanil given
References: Allen et al., 1991

VERVET, *Cercopithecus pygerythrus*
Weight: 3–8 kg
Recommended Drug: 7 mg/kg Telazol®

Supplemental Drug: 7 mg/kg ketamine
Antagonist: None
Alternative Drugs: 12 mg/kg ketamine
References: Kroll, 1962; Graham-Jones, 1964; Beck, 1976; Eads, 1976; Schobert, 1987; Burroughs, 1993c

VICUÑA, *Vicugna vicugna*
Weight: 35–65 kg
Recommended Drug: 1 mg/kg ketamine plus 0.05 mg/kg medetomidine
Supplemental Drug: 1 mg/kg ketamine
Antagonist: 0.25 mg/kg atipamezole
Alternative Drugs: 2 mg/kg xylazine; antagonize with 0.125 mg/kg yohimbine
• 4 mg/kg Telazol®
Comments: Jones (1977a) stated that the use of opioids in llama was contraindicated; assume the same for vicuña.
References: Wiesner and von Hegel, 1985; Schiappacasse Faundes, 1991

VULTURE, CAPE, *Gyps coprotheres*
Weight: 5–7 kg
Recommended Drug: 10 mg/kg ketamine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Ebedes, 1973a; Van Heerden et al., 1987

VULTURE, TURKEY, *Cathartes aura*
Weight: 5–7 kg
Recommended Drug: 35 mg/kg ketamine plus 0.7 mg/kg diazepam, IV
Supplemental Drug: 5 mg/kg ketamine, IV
Antagonist: None
References: Redig and Diuke, 1976; Allen and Oosterhuis, 1986a

WALLABY, AGILE, *Macropus agilis*
Weight: 12–20 kg
Recommended Drug: 8 mg/kg ketamine plus 8 mg/kg xylazine
Supplemental Drug 4 mg/kg ketamine only
Antagonist: None
References: Kroll, 1962; Keep, 1973

WALLABY, BRUSH-TAILED ROCK, *Petrogale penicillata*
Weight: 3–9 kg
Recommended Drug: 6 mg/kg Telazol®
Supplemental Drug: 6 mg/kg ketamine
Antagonist: None
References: Holz, 1992; Shima et al., 1993

WALLABY, PARMA, *Macropus parma*
Weight: 2.6–5.9 kg
Recommended Drug: 6.5 mg/kg Telazol®
Supplemental Drug: 6.5 mg/kg ketamine
Antagonist: None
References: Bush et al., 1990

WALLABY, RED-NECKED, *Macropus rufogriseus*
Weight: 10–25 kg
Recommended Drug: 8 mg/kg ketamine plus 8 mg/kg xylazine
Supplemental Drug: 4 mg/kg ketamine only
Antagonist: None reported
Alternative Drugs: 5 mg/kg ketamine plus 0.1 mg/kg medetomidine; antagonize with 0.5 mg/kg atipamezole
• 7 mg/kg Telazol®
References: Seal and Erickson, 1969; Seal et al., 1970; Denny, 1974; Wiesner, 1977; England and Kock, 1988; Kock et al., 1989; Jalanka and Roeken, 1990; Holz, 1992; Shima et al., 1993; Holz and Barnett, 1996

WALLABY, SWAMP, *Wallabia bicolor*
Weight: 10.3–15.4 (f), 12.3–20.5 (m) kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Denny, 1974; Shima et al., 1993

WALLABY, TAMMAR, *Macropus eugenii*
Weight: 12–20 kg
Recommended Drug: 8 mg/kg ketamine plus 8 mg/kg xylazine
Supplemental Drug: 4 mg/kg ketamine only
Antagonist: None
References: Denny, 1974; Richardson and Cullen, 1981; 1984

WALLAROO, *Macropus robustus*
Weight: 20–40 kg
Recommended Drug: 19 mg/kg ketamine
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
References: Marlow, 1956; Denny, 1974; Finnie, 1976

WALRUS, *Odobenus rosmarus*
Weight: 400–1,250 (f), 800–1,700 (m) kg
Recommended Drug: 2 mg/kg Telazol®
Supplemental Drug: 1 mg/kg ketamine
Antagonist: None

Alternative Drugs: 0.006 mg/kg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given
Comments: When using etorphine, monitor for apnea and be prepared to administer antagonist. Administer drugs as described in Stirling and Sjare (1988). Some workers have had increased mortality using Telazol® when working in higher ambient temperatures than Stirling and Sjare (1988).
References: DeMaster et al., 1981; Ryding, 1982; Cornell and Antrim, 1987; Joseph and Cornell, 1988; Stirling and Sjare, 1988; Walsh et al., 1988; Gales, 1989; Born and Knutsen, 1990; Williams et al., 1990a; Griiffiths et al., 1993

WAPITI - SEE ELK

WART HOG, *Phacochoerus aethiopicus*
Weight: 65–100 kg
Recommended Drug: 3 mg/kg Telazol®
Supplemental Drug: 2 mg/kg ketamine
Antagonist: None
Alternative Drugs: 4 mg etorphine plus 20 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 15 mg fentanyl plus 50 mg acepromazine; antagonize with 0.2 mg/kg naltrexone or naloxone
Comments: Wart hogs are not easy to immobilize and they are highly susceptible to overheating. Do not overly stress before darting and keep cool after immobilization. Overdose of etorphine can cause cardiac arrest. Use low-impact darting systems. Ketamine combinations and Telazol® may result in light anesthesia, poor analgesia, and muscle spasms. Respiratory depression can be severe with opioids.
References: Bigalke, 1965; Pienaar et al., 1966a; Pienaar, 1969a; 1969b; Harthoorn, 1972a; 1973a; 1973b; Jones, 1972; De Vos, 1975; Röken, 1975; Smuts, 1975; Haigh, 1976d; IWVS, 1992; Burroughs, 1993e

WATERBUCK, *Kobus ellipsiprymnus*
Weight: 225–260 kg
Recommended Drug: 0.01 mg/kg carfentanil plus 0.1 mg/kg xylazine
Supplemental Drug: If animal is not down in 20 minutes, repeat full dose
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine
Alternative Drugs: 0.03 mg/kg etorphine plus 0.25 mg/kg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 50 mg fentanyl plus 300 mg azaperone
• 1.6 ml Large Animal Immobilon® plus 25 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given
Comments: Difficult to immobilize. Prone to excessive running during induction with opioids; monitor for hyperthermia. Susceptible to capture

myopathy. Carfentanil used without tranquilizers causes marked excitability.
References: Buechner et al., 1960a; 1960c; Harthoorn and Bligh, 1965; Pienaar et al., 1966a; Hanks, 1967; Keep and Keep, 1967; Short and Spinage, 1967; Hanks and Dowsett, 1969; Pienaar, 1969b; Bauditz, 1972; Heck and Rivenburg, 1972; Jones, 1972; Pienaar, 1968a; 1973a; De Vos, 1975; Rapley and Mehren, 1975; Röken, 1975; York, 1975; Haigh, 1976d; De Vos, 1978a; Kupper et al., 1981; Wiesner et al., 1982; 1984; 1985; Janssen and Oosterhuis, 1984; Silvestris and Heck, 1984; Wiesner and von Hegel, 1985; Kock et al., 1989; Allen et al., 1991; Janssen et al., 1991; IWVS, 1992; Burroughs, 1993d

WATERFOWL, GENERAL
Recommended Drug: 25 mg/kg ketamine plus 1 mg/kg diazepam
Supplemental Drug: 15 mg/kg ketamine
Antagonist: None
References: Amand, 1982a

WEASEL LONG-TAILED, *Mustela frenata*
Weight: 85–200 gm
Recommended Drug: 0.005 mg/gm ketamine plus 0.0001 mg/gm medetomidine
Supplemental Drug: 0.0025 mg/gm ketamine
Antagonist: 0.0005 mg/gm atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 0.03 mg/gm ketamine
References: Seal et al., 1970; Jessup, 1982b; Seal and Kreeger, 1987

WEASEL-SHORT-TAILED - SEE ERMINE

WILDEBEEST, (BLACK, WHITE-TAILED), *Connochaetes gnou*
Weight: 118–275 kg
Recommended Drug: 0.007 mg/kg carfentanil plus 0.06 mg/kg xylazine
Supplemental Drug: 0.007 mg/kg carfentanil
Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given
Alternative Drugs: 3 mg etorphine plus 15 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 1 ml Large Animal Immobilon® plus 10 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
- 3 mg/kg xylazine; antagonize with 0.125 mg yohimbine (calm animals only)

Comments: Wildebeest are susceptible to capture myopathy if over-exerted.
References: Pienaar, 1969b; 1973; Gauckler and Kraus, 1970; Amand et al., 1972; Bauditz, 1972; Heck and Rivenburg, 1972; Keep, 1973a; Gray et al., 1974; De Vos, 1975; Rapley and Mehren, 1975; Röken, 1975; Haigh, 1976d; De Vos, 1978a; Wiesner et al., 1982; 1984; Silvestris and Heck, 1984; Wiesner et al., 1984; Wiesner and von Hegel, 1985; Hugues et al., 1986; Schobert, 1987; Williams and Riedesel, 1987; Allen et al., 1991; Berry, 1992; IWVS, 1992; Burroughs, 1993d

WILDEBEEST, (BLUE, BRINDLED, WHITE-BEARDED), *Connochaetes taurinus*

Weight: 118–275 kg

Recommended Drug: 0.008 mg/kg carfentanil plus 0.08 mg/kg xylazine

Supplemental Drug: If animal is not down in 20 minutes, repeat full dose

Antagonist: 100 mg naltrexone or naloxone per mg carfentanil given plus 0.125 mg/kg yohimbine

Alternative Drugs: 4 mg etorphine plus 20 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine

- 6.6 mg/kg Telazol®
- 20 mg fentanyl plus 75 mg azaperone
- 3 mg/kg xylazine; antagonize with 0.125 mg yohimbine (calm animals only)

Comments: Wildebeest are susceptible to capture myopathy if over-exerted. Monitor respiration rates closely.

References: Heuschele, 1961a; 1961b; Talbot and Lamprey, 1961; Talbot and Talbot, 1962; Harthoorn, 1962b; Van Niekerk et al., 1963a; 1963b; Orr and Moore-Gilbert, 1964; Harthoorn and Bligh, 1965; Hirst et al., 1965; Pienaar et al., 1966a; 1968a; Fenn and Sedgwick, 1969; Pienaar, 1969b; Harthoorn, 1971; Koci, 1971a; 1972; Bauditz, 1972; Jones, 1972; York and Huggins, 1972; Keep, 1973; Young and Whyte, 1973; De Vos, 1975; Röken, 1975; Smuts, 1975; Grootenhuis et al., 1976; Haigh, 1976d; Ebedes et al., 1977; Slee and Walker, 1977; De Vos, 1978a; Arora et al., 1983; Schobert, 1987; Williams and Riedesel, 1987; Kock et al., 1989; Allen et al., 1991; IWVS, 1992; Burroughs, 1993d

WISENT - SEE BISON, EUROPEAN

WOLF, ETHIOPIAN - SEE JACKAL, SIMIEN

WOLF, GRAY, *Canis lupus*

Weight: 27–60 kg

Recommended Drug: 10 mg/kg ketamine plus 2 mg/kg xylazine

Supplemental Drug: 5 mg/kg ketamine

Antagonist: 0.15 mg/kg yohimbine

Alternative Drugs: 4 mg/kg ketamine plus 0.08 mg/kg medetomidine; antagonize with 0.4 mg/kg atipamezole

- 10 mg/kg Telazol® plus 1.5 mg/kg xylazine
- 10 mg/kg ketamine plus 0.15 mg/kg acepromazine

Comments: If using ketamine and xylazine, wait at least 45 min after last ketamine or Telazol® injection before administering yohimbine. Calm, captive wolves may be able to be immobilized with 4 mg/kg ketamine plus 2 mg/kg xylazine. This combination is more readily antagonized by yohimbine than when higher doses of ketamine are used. Atropine at 0.05 mg/kg can be given to decrease salivation, particularly when wolves are immobilized with Telazol®.

References: Kroll, 1962; Dyson, 1965; Seal and Erickson, 1969; Göltenboth

and Klös, 1970; 1987; Seal et al., 1970a; Bauditz, 1972; Alford et al., 1974; Gray et al., 1974; Wentges, 1975; Wiesner, 1975; 1977; Haigh, 1976d; Boever et al., 1977b; Philo, 1978; Fuller and Keith, 1981; Ballard et al., 1982; 1991; Fuller and Kuehn, 1983; Genevois et al., 1984b; Wiesner et al., 1984; Duchamps, 1985; Hess and Knakal, 1985; Tobey and Ballard, 1985; Wiesner and von Hegel, 1985; Hugues et al., 1986; Kreeger and Seal, 1986a; 1990; Kreeger et al., 1986c; 1987a; 1988; 1989a; 1990c; 1990d; 1990e; 1995; 1996; Schobert, 1987; Seal and Kreeger, 1987; Strauss, 1987; Kock et al., 1989; Jalanka and Roeken, 1990; Mech and Gese, 1992; Holz et al., 1994; Pond and O'Gara, 1994; Vilà and Castroviejo, 1994

WOLF, IBERIAN - SEE WOLF, GRAY

WOLF, MANED, *Chrysocyon brachturus*
Weight: 20–23 kg
Recommended Drug: 2.5 mg/kg ketamine plus 0.08 mg/kg medetomidine
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: 0.4 mg/kg atipamezole
Alternative Drugs: 10 mg/kg Telazol®
• 10 mg/kg ketamine plus 0.1 mg/kg acepromazine
References: Graham-Jones, 1964; Jalanka and Roenken, 1990

WOLF, MEXICAN, *Canis lupus baileyi*
Weight: 23–28 kg
Recommended Drug: 4.2 mg/kg ketamine plus 2.3 mg/kg xylazine
Supplemental Drug: 2.3 mg/kg ketamine
Antagonist: 0.15 mg/kg yohimbine
Alternative Drugs: 10 mg/kg Telazol®
• 4 mg/kg ketamine plus 0.08 mg/kg medetomidine; antagonize with 0.4 mg/kg atipamezole
• 10 mg/kg ketamine plus 0.1 mg/kg acepromazine
References: Servin and Huxley, 1992

WOLF, RED, *Canis rufus*
Weight: 20–40 kg
Recommended Drug: 10 mg/kg ketamine plus 2 mg/kg xylazine
Supplemental Drug: 5 mg/kg ketamine
Antagonist: 0.15 mg/kg yohimbine
Alternative Drugs: 10 mg/kg Telazol®
• 10 mg/kg ketamine plus 0.1 mg/kg acepromazine
Comments: If using xylazine, wait at least 45 min after last ketamine injection before administering yohimbine.
References: Seal et al., 1970; Seal and Kreeger, 1987

WOLVERINE, *Gulo gulo*
Weight: 7–32 kg
Recommended Drug: 5 mg/kg ketamine plus 0.1 mg/kg medetomidine
Supplemental Drug: 2.5 mg/kg ketamine
Antagonist: 0.2 mg/kg atipamezole; give 1/2 dose IV, 1/2 IM
Alternative Drugs: 20 mg/kg ketamine plus 0.2 mg/kg acepromazine
• 0.1 mg/kg etorphine plus 1 mg/kg xylazine; antagonize with 0.2 mg/kg diprenorphine plus 0.15 mg/kg yohimbine
References: Seal and Erickson, 1969; Seal et al., 1970; Hash and Hornocker, 1980; Ballard et al., 1982; Wright, 1983; Wiesner and von Hegel, 1985; Röken, 1987; Seal and Kreeger, 1987; Jalanka and Roeken, 1990

WOMBAT, *Vombatus ursinus*
Weight: 15–35 kg
Recommended Drug: 5 mg/kg Telazol®
Supplemental Drug: 5 mg/kg ketamine
Antagonist: None
References: Denny, 1974; Holz, 1992; Bush et al., 1990; Shima et al., 1993

WOMBAT, SOUTHERN HAIRY-NOSE, *Lasiorhinus latifrons*
Weight: 19–32 kg
Recommended Drug: 3 mg/kg Telazol®
Supplemental Drug: 3 mg/kg ketamine
Antagonist: None
References: Shima et al., 1993

WOODCHUCK, *Marmota monax*
Weight: 3–7.5 kg
Recommended Drug: 20 mg/kg ketamine plus 3 mg/kg xylazine
Supplemental Drug: 10 mg/kg ketamine
Antagonist: None
Alternative Drugs: 5 mg/kg Telazol®
References: Mosby and Cantner, 1956; Seal and Erickson, 1969; Seal et al., 1970; Noyes and Siekierski, 1975; Young and Sims, 1979; Wright, 1983; Genevois et al., 1984a

YAK, *Bos grunniens*
Weight: 250–400 (f), 800–1,000 (m) kg
Recommended Drug: 0.06 mg/kg etorphine plus 0.4 mg/kg xylazine
Supplemental Drug: 0.03 mg/kg etorphine
Antagonist: 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Alternative Drugs: 1 mg/kg xylazine
• 3 mg/kg ketamine plus 0.1 mg/kg medetomidine; antagonize with 0.5 mg/kg atipamezole

• 2.5 ml Large Animal Immobilon® plus 50 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
References: Bauditz, 1972; Heck and Rivenburg, 1972; Mehren and Rapley, 1975; Rapley and Mehren, 1975; Williams and Riedesel, 1987; Kock et al., 1989; Jalanka and Roeken, 1990

ZEBRA, BURCHELL'S (COMMON), *Equus burchelli*
Weight: 200–340 kg
Recommended Drug: 6 mg etorphine (male), 4 mg etorphine (female) plus 80 mg/kg azaperone
Supplemental Drug: If not down in in 20 min, repeat full dose
Antagonist: 2.4 mg diprenorphine per mg etorphine given
Alternative Drugs: 6 mg etorphine plus 100 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 2.5 ml Large Animal Immobilon® plus 50 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: Complete muscle relaxation is difficult to obtain with wild equids; excessive leg movement is common. Wild equids tend to overheat easily, particularly if there is a prolonged hyperexcitable state prior to anesthetic induction. Attempt to immobilize equids during the coolest part of the day. Etorphine may be more effective than carfentanil in zebras. Zebra skin is resilient sometimes making dart penetration difficult, but do not dart from behind because the skin of the perineum is soft and penetration of the abdomen can result. Dart wounds often bleed profusely; be sure to treat all dart wounds before release. Opioids result in poor muscle relaxation; administer 10 mg diazepam to improve relaxation. Blindfolding is recommended.
References: Talbot and Lamprey, 1961; Talbot and Talbot, 1962; Lanphear, 1963; Van Niekerk et al., 1963a; Wright, 1963; Bigalke, 1965; Harthoorn, 1965a; 1971; 1972a; 1973b; Harthoorn and Bligh, 1965; King and Klingel, 1965; Ebedes, 1966a; 1971a; Pienaar et al., 1966a; Ericksen, 1968; Klingel, 1968; Wallach, 1968; 1969; Pienaar, 1968a; 1969b; Taylor and Chandler, 1971; Bauditz, 1972; Heck and Rivenburg, 1972; Higgins, 1973; Harthoorn and Young, 1974; Hertzog, 1975; Rapley and Mehren, 1975; Röken, 1975; Jones, 1976; Oosterhuis, 1979; Hofmeyr, 1981; Wiesner et al., 1982; Silvestris and Heck, 1984; Kock and Pearce, 1985; Wiesner and von Hegel, 1985; IWVS, 1992; Burroughs, 1993f; Lin et al., 1993; Wiesner, 1993

ZEBRA, GREVY, *Equus grevyi*
Weight: 352–450 kg
Recommended Drug: 6 mg etorphine plus 25 mg/kg acepromazine
Supplemental Drug: If not down in in 20 min, repeat full dose
Antagonist: 2 mg diprenorphine per mg etorphine given
Alternative Drugs: 6 mg etorphine plus 100 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 2.5 ml Large Animal Immobilon® plus 50 mg xylazine; antagonize with 2

mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
Comments: Complete muscle relaxation is difficult to obtain with wild equids; excessive leg movement is common. Wild equids tend to overheat easily, particularly if there is a prolonged hyperexcitable state prior to anesthetic induction. Attempt to immobilize equids during the coolest part of the day. Etorphine may be more effective than carfentanil in zebras. Zebra skin is resilient making dart penetration difficult. Dart wounds often bleed profusely. Opioids result in poor muscle relaxation; administer 10 mg diazepam to improve relaxation. Blindfolding is recommended.
References: Lock and Harthoorn, 1959; Buechner et al., 1960a; 1960c; Lanphear, 1963; Wright, 1963; Heck and Rivenburg, 1972; Alford et al., 1974; Rapley and Mehren, 1975; Röken, 1975; Jones, 1976; Oosterhuis, 1979; Jessup et al., 1980; Wiesner et al., 1982; Bristol et al., 1984; Kock and Pearce, 1985; Wiesner and von Hegel, 1985; Pospisil et al., 1989; Allen, 1990a; Klein and Citino, 1995

ZEBRA, MOUNTAIN, *Equus zebra*
Weight: 150–350 kg
Recommended Drug: 6 mg etorphine (male), 4 mg etorphine (female) plus 80 mg/kg azaperone
Supplemental Drug: If not down in in 20 min, repeat full dose
Antagonist: 2.4 mg diprenorphine per mg etorphine given
Alternative Drugs: 6 mg etorphine plus 100 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 2.5 ml Large Animal Immobilon® plus 50 mg xylazine; antagonize with 2 mg diprenorphine per mg etorphine given plus 0.125 mg/kg yohimbine
• 0.011 mg/kg carfentanil; antagonize with 100 mg naltexone or naloxone per mg carfentanil given
Comments: Complete muscle relaxation is difficult to obtain with wild equids; excessive leg movement is common. Wild equids tend to overheat easily, particularly if there is a prolonged hyperexcitable state prior to anesthetic induction. Attempt to immobilize equids during the coolest part of the day. Etorphine may be more effective than carfentanil in zebras. Zebra skin is resilient sometimes making dart penetration difficult, but do not dart from behind because the skin of the perineum is soft and penetration of the abdomen can result. Dart wounds often bleed profusely; be sure to treat all dart wounds before release. Opioids result in poor muscle relaxation; administer 10 mg diazepam to improve relaxation. Blindfolding is recommended.
References: Heck and Rivenburg, 1972; Young and Penzhorn, 1972; Röken, 1975; Oosterhuis, 1979; Jones, 1976; Hofmeyr, 1981; Wiesner et al., 1982; Silvestris and Heck, 1984; Kuttner and Wiesner, 1987; Burroughs, 1993f; Allen, 1990a; 1994

ZEBU, *Bos taurus*

Weight: 800–1,000 kg

Recommended Drug: 3.6 mg/kg Telazol®

Supplemental Drug: 1 mg/kg ketamine

Antagonist: None

Alternative Drugs: 8 mg etorphine; antagonize with 2 mg diprenorphine per mg etorphine given

References: Jarvis and Morris, 1960; Beck, 1972; Woolf et al., 1973; Wiesner, 1975; Wiesner and von Hegel, 1985; Schobert, 1987

References

Abbott, C. W. 1973. Reactions of eland to immobilising drugs. Lammergeyer. 18: 30-38.

Ables, E. D. 1969. Field immobilization of free ranging impala in northern Kenya. E. Afr. Wildl. J. 7: 61-66.

Addison, E. M., G. B. Kolenosky. 1979. Use of ketamine hydrochloride and xylazine hydrochloride to immobilize black bears (*Ursus americanus*). J. Wildl. Dis. 15: 253-258.

Adest, G. A., J. Jarchow, and B. Brydolf. 1988. A method for manual ventilation of tranquilized tortoises. Herpetol. Rev. 19: 80.

Aird, S. D. 1986. Methoxyflurane anesthesia in Crotalus: Comparisons with other gas anesthetics. Herpetol. Rev. 17: 82-84.

Agoramoorthy, G, and R. Rudran. 1994. Field application of Telazol (tiletamine hydrochloride and zolazepam hydrochloride) to immobilize wild red howler monkeys (*Alouatta seniculus*) in Venezuela. J. Wildl. Dis. 30: 417-420.

Aguilar, R. F., V. E. Smith, P. Ogburn, and P. T. Redig. 1996. Arrhythmias associated with isoflurane anesthesia in bald eagles (*Haliaeetus leucocephalus*). J. Zoo Wildl. Med. 26: 508-516.

Akhari, S., and S. Dehghani. 1993. Introduction of a recirculator for longterm anaesthesia applicable in the surgery of fishes. J. Vet. Faculty U. Tehran. 47: 15-22.

Alford, B. T., L. Burkhart, W. P. Johnson. 1974. Etorphine and diprenorphine as immobilizing and reversing agents in captive and free-ranging mammals. J. Am. Vet. Med. Assoc. 154: 701-705.

Alkon, P. U. 1984. Chemical restraint of Indian crested porcupines (*Hysterix indica*). Mammalia. 48: 150-152.

Allen, J. L. 1986a. Use of tolazoline as an antagonist to xylazine-ketamine-induced immobilization in African elephants. Am. J. Vet. Res. 47: 781-783.

Allen, J. L. 1986b. Tolazoline antagonism of xylazine-ketamine immobilization in selected non-domestic hoofstock. Proc. Am. Assoc. Zoo Vet. Pp. 3-4.

Allen, J. L. 1989. Renarcotization following carfentanil immobilization of nondomestic ungulates. J. Zoo An. Med. 20: 423-426.

Allen, J. L. 1990a. Renarcotization following etorphine immobilization of nondomestic Equidae. J. Zoo An. Med. 21: 292-294.

Allen, J. L. 1990b. Pulse oximetry: clinical applications in zoological medicine. Proc. Am. Assoc. Zoo Vet. 163-164.

Allen, J. L. 1992a. Immobilization of Mongolian wild horses (*Equus przewalskii przewalskii*) with carfentanil and antagonism with naltrexone. J. Zoo Wildl. Med. 23: 422-425.

Allen, J. L. 1992b. Immobilization of giant Chacoan peccaries (*Catagonus wagneri*)

with a tiletamine hydrochloride/zolazepam hydrochloride combination. J. Wildl. Dis. 28: 499-501.

Allen, J. L. 1994. Immobilization of Hartmann's mountain zebras (*Equus zebra hartmannae*) with carfentanil and antagonism with naltrexone or nalmefene. J. Zoo Wildl. Med. 25: 205-208.

Allen, J. L., and J. E. Oosterhuis. 1986a. Effect of tolazoline on xylazine-ketamine-induced anesthesia in turkey vultures. J. Am. Vet. Med. Assoc. 189: 1011-1012.

Allen, J. L., and J. E. Oosterhuis. 1986b. Use of tolazoline as an antagonist to xylazine-ketamine anesthesia in selected avian species. Proc. Annu. Meet. Assoc. Avian Vet. 1986: 281-282.

Allen, J. L., D. L. Janssen, J. E. Oosterhuis, and T. H. Stanley. 1991. Immobilization of captive non-domestic hoofstock with carfentanil. Proc. Am. Assoc. Zoo Vet. Pp. 343-353.

Allen, K. E. 1965. Immobilizing beaver with succinylcholine chloride. Game Res. Ohio. 3: 215-220.

Allen, T. J. 1970. Immobilization of white-tailed deer with succinylcholine chloride and hyaluronidase. J. Wildl. Manage. 34: 207-209.

Allsup, F. C. 1977. Accidental self injection. Vet. Rec. 100: 499.

Althouse, G. C., C. M. Hodges, S. J. Magyar, T. G. Biediger, and S. W. J. Seager. 1987. Immobilization of a pregnant nilgai (*Boselaphus tragocamelus*) using a combination of etorphine, xylazine, and acepromazine with reversal using yohimbine and diprenorphine. Southwest Vet. 38: 47-50.

Altman, R. B., and M. S. Miller. 1979. Effects of anesthesia on the temperature and electrocardiogram of birds. Proc. Am. Assoc. Zoo Vet. Pp. 61-62.

Amand, W. B. 1980. Avian anesthetic agents and techniques – a review. Proc. Am. Assoc. Zoo Vet. 8: 68-72.

Amand, W. B., H. W. Calderwood, C. E. Harvey, G. W. McConnel, and A. M. Klide. 1972. Chemical restraint of a black gnu (*Connachaetes gnou*) with BAY-VA 1470. J. Zoo An. Med. 2: 22-25.

Amand, W. B. 1982a. Chemical immobilization of birds. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Milwaukee, Wisconsin: Wisconsin Humane Society, Inc. Pp. 199-213.

Amand, W. B. 1982b. Chemical immobilization of reptiles. *In* Nielsen, L, J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Milwaukee, Wisconsin: Wisconsin Humane Society, Inc. Pp. 199-213.

Amstrup, S. C., and T. B. Segerstrom. 1981. Immobilizing free-ranging pronghorns with powdered succinylcholine chloride. J. Wildl. Manage. 45: 740-745.

Amstrup, S. C., B. W. O'Gara, and H. Musgrave. 1982. Immobilizing elk with powdered succinylcholine chloride. Wildl. Soc. Bull. 10: 333-340.

Ancrenaz, M. 1994. Use of atipamezole to reverse xylazine tranquilization in captive Arabian oryx (*Oryx leucoryx*). J. Wildl. Dis. 30: 592-595.

Ancrenaz, M., S. Ostrowski, A. Delhomme, and A. Greth. 1995. Latest developments in translocation techniques of the Arabian Oryx, *Oryx leucoryx*. Proc.

Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 184-189.

Ancrenaz, M., S. Ostrowski, S. Anagariyah, and A. Delhomme. 1996. Long-duration anesthesia in Arabian oryx (*Oryx leucoryx*) using a medetomidine-etorphine combination. J. Zoo Wildl. Med. 27: 209-216.

Andau, P. M., L. K. Hiong, and J. B. Sale. 1994. Translocation of pocketed orangutans in Sabah. Oryx 28: 263-268.

Anderson, C. F. 1961. Anesthetizing deer by arrow. J. Wildl. Manage. 25: 202-203.

Anderson, M. D., and P. R. K. Richardson. 1992. Remote immobilization of the aardwolf. So. Afr. J. Wildl. Res. 22: 26-28.

Andryk, T. A., L. R. Irby, D. L. Hook, J. J. McCarthy, and G. Olson. 1983. Comparison of mountain sheep capture techniques: helicopter darting versus net-gunning. Wildl. Soc. Bull. 11: 184-187.

Anonymous. 1976. Veterinary surgeon's Immobilon death "accidental." Vet. Rec. 98: 414-415.

Apelt, H. J. 1993. Use of tiletamine-zolazepam combination as an injectable anaesthetic and as a premedication for isoflurane anaesthesia in tortoises. Tierarztliche Hochscule, Hannover. 111 pp.

April, M., E. Tabor, and R. J. Gerety. 1982. Combination of ketamine and xylazine for effective anesthesia of juvenile chimpanzees (*Pan troglodytes*). Lab. An. 16: 116-118.

Arena, P. C., K. C. Richardson, and L. K. Cullen. 1988. Anaesthesia in two species of large Australian skink. Vet. Rec. 123: 155-158.

Armstrong, D. L. 1989. An evaluation of carfentanil as an immobilizing agent for gaur (*Bos gaurus*). Proc. Am. Assoc. Zoo Vet. P. 8.

Arnemo, J. M. 1989. Surgical implantation of intraperitoneal radiotelemetry devices in European river otters (*Lutra lutra*). Proc. V Int. Otter Colloquium - Habitat 7, Hankensbüttel.

Arnemo, J. M. 1995. Immobilization of free-ranging moose (*Alces alces*) with medetomidine-ketamine and remobilization with atipamezole. Rangifer 15:19-25.

Arnemo, J. M., and N. E. Søli. 1992. Immobilization of mink (*Mustela vison*) with medetomidine-ketamine and remobilization with atipamezole. Vet. Res. Comm. 16: 281-292.

Arnemo, J. M., and N. E. Søli. 1993. Chemical capture of free-ranging cattle: immobilization with xylazine or medetomidine, and reversal with atipamezole. Vet. Res. Comm. 17: 469-477.

Arnemo, J. M., and N. E. Søli. 1994. Injection darts containing drugs - a potential health hazard for several years? Norsk Veterinaer. 106: 306-308.

Arnemo, J. M., and N. E. Søli. 1995. Chemical immobilization of free-ranging European hedgehogs (*Erinaceus europaeus*). J. Zoo Wildl. Med. 26: 246-251.

Arnemo, J. M., R. Moe, and A. J. Smith. 1993a. Immobilization of captive raccoon dogs (*Nyctereutes procyonoides*) with medetomidine-ketamine and remobilization with atipamezole. J. Zoo Wildl. Med. 24: 102-108.

Arnemo, J. M., T. Negard, and N. E. Søli 1993b. Deer farming in Norway. A review of the currently available drugs that can be used for immobilization, pain relief, and anaesthesia. Norsk Veterinaer. 105: 517-521.

Arnemo, J. M., R. Moe, and N. E. Søli. 1993c. Xylazine-induced sedation in axis deer (*Axis axis*) and its reversal by atipamezole. Vet. Res. Comm. 17: 123-128.

Arnemo, J. M., T. Soveri, Ø. Os, and N. E. Søli. 1994a. Immobilization of free-ranging moose (*Alces alces*) with medetomidine-ketamine and reversal with atipamezole. Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. Pp. 197-199.

Arnemo, J. M., T. Negard, and N. E. Søli. 1994b. Chemical capture of free-ranging red deer (*Cervus elaphus*) with medetomidine-ketamine. Rangifer 14: 123-127.

Arnemo, J. M., R. O. Moe, and N. E. Søli. 1994c. Immobilization of captive pine martens (*Martes martes*) with medetomidine-ketamine and reversal with atipamezole. J. Zoo Wildl. Med. 25: 548-554.

Arnold, G. W., D. Steven, J. Weeldenburg, and O. E. Brown. 1986. The use of alpha-chloralose for the repeated capture of Western grey kangaroos, *Macropus fuliginosus*. Aust. Wildl. Res. 13: 527-533.

Arora, B. M. 1988. Chemical immobilization of deer and antelopes. Tigerpaper. 15: 8-14.

Arora, B. M., H. Wiesner, and A. K. Malhotra. 1983. A note on chemical immobilization of zoo animals with blow pipe. Indian J. Vet. Surg. 4: 78-81.

Arthur, S. M. 1988. An evaluation of techniques for capturing and radiocollaring fishers. Wildl. Soc. Bull. 16: 417-421.

Austin, D. H., and J. H. Peoples. 1967. Capturing hogs with alpha-chloralose. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 21: 201- 203.

Autenrieth, R. E., G. L. Copeland, and T. D. Reynolds. 1981. Capturing pronghorn using a helicopter and etorphine hydrochloride. Wildl. Soc. Bull. 9: 314-319.

Baber, D. W., and E. C. Bruce. 1982. Immobilization of feral pigs with a combination of ketamine and xylazine. J. Wildl. Manage 46: 557-559.

Bacher, J. D., S. Potkay, and E. J. Baas. 1976. An evaluation of sedatives and anesthetics in the agouti (*Dasyprocta sp.*). Lab. An. Sci. 26: 195-197.

Backhouse, K. M. 1964. The anesthesia of marine mammals. *In* Jones, G. (ed.). Small Animal Anesthesia. Pergamon Press, London. Pp. 79-82.

Baer, C. H., R. E. Severson, and S. B. Linhart. 1978. Live capture of coyotes from a helicopter with ketamine hydrochloride. J. Wildl. Manage. 42: 452-454.

Baharav, D. and A. Tadmor. 1981. Immobilization of mountain gazelles with M99. Mammalia. 45: 391-393.

Bailey, P. L., J. D. Port, N. L. Pace, T. H. Stanley, and J. Kimball. 1985. The ED_{50} of carfentanil for elk immobilization with and without the tranquilizer R51703. J. Wildl. Manage. 49: 931-934.

Bailey, P. L., D. Port, S. McJames, L. Reinersman, and T. H. Stanley. 1987. Is fentanyl an anesthetic in the dog? Anesth. Analg. 66: 542-548.

Bailey, R. W. 1972. Use of stimulants in reducing mortality in narcotized wild

turkeys. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 26: 212-213.

Bailey, R. W., and R. V. Doepker. 1977. Problems in capturing wild turkeys with trichloroethanol. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 31: 283-284.

Bailey, T. N. 1971. Immobilization of bobcats, coyotes, and badgers with phencyclidine hydrochloride. J. Wildl. Manage. 35: 847-849.

Bailey, T. A., C. A. Baker, P. K. Nicholls, and K. Wilson. 1995. Reversible anesthesia of the blue duiker (*Cephalophus monticola*) with medetomidine and ketamine. J. Zoo Wildl. Med. 26: 237-239.

Baker, J. R., and T. J. Gatesman. 1985. Use of carfentanil and a ketamine-xylazine mixture to immobilise wild grey seals (*Halichoerus grypus*). Vet. Rec. 116: 208-210.

Baker, J. R., S. S. Anderson, and M. A. Fedak. 1988. The use of ketamine-diazepam mixture to immobilise wild grey seals (*Halichoerus grypus*) and southern elephant seals (*Mirounga leonina*). Vet. Rec. 123: 287-289.

Baker, J. R., M. A. Fedak, S. S. Anderson, T. Arnborn, and R. Baker. 1990. The use of tiletamine/zolazepam mixture to immobilize wild grey seals and southern elephant seals. Vet. Rec. 126: 75-77.

Ballard, W. B., and R. W. Tobey. 1981. Decreased calf production of moose immobilized with anectine administered from helicopter. Wildl. Soc. Bull. 9: 207-209.

Ballard, W. B., A. W. Franzmann, and C. L. Gardner. 1982. Comparison and assessment of drugs used to immobilize Alaskan gray wolves (*Canis lupus*) and wolverines (*Gulo gulo*) from a helicopter. J. Wildl. Dis. 18: 339-342.

Ballard, W. B., L. A. Ayres, K. E. Roney, and T. H. Spraker. 1991. Immobilization of gray wolves with a combination of tiletamine hydrochloride and zolazepam hydrochloride. J. Wildl. Manage. 55: 71-74.

Balser, D. S. 1965. Tranquilizer tabs for capturing wild carnivores. J. Wildl. Manage. 29: 438-442.

Banknieder, A. R., J. M. Phillips, K. T. Jackson, and S. I. Vinal. 1978. Comparison of ketamine with the combination of ketamine and xylazine for effective anesthesia in the rhesus monkey (*Macaca mulatta*). Lab. An. Sci. 28: 742-745.

Barnard, S. M., and J. S. Dobbs. 1980. A handmade blowgun dart: it's preparation and application in a zoological park. J. Am. Vet. Med. Assoc. 177: 953-955.

Barnes, D. M., and L. L. Rogers. 1980. Clostridial myonecrosis in a black bear associated with drug administration. J. Wildl. Dis. 17: 95-110.

Barnett, J. E. F., and J. C. M. Lewis. 1990. Medetomidine and ketamine anaesthesia in zoo animals and its reversal with atipamezole: a review and update with specific reference to work in British zoos. Proc. Am. Assoc. Zoo Vet. Pp. 207-214.

Barrett, M., J. W. Nolan, and L. D. Roy. 1982. Evaluation of a hand-held net-gun to capture large mammals. Wildl. Soc. Bull. 10: 108-114.

Barry, W. J. 1972. Methoxyflurane: an anesthetic for field and laboratory use on squirrels. J. Wildl. Manage. 36: 992-993.

Bartmann, W. 1972. Korrekturmassnahmen nach spontaner Gehörndeformation

beim Jacksons Hartebeest (*Alcelaphus busephalus jacksoni*). Zool. Garten. 42: 159-165.

Bartsch, R. C., E. E. McConnell, G. D. Imes, and J. M. Schmidt. 1977. A review of exertional rhabdomyolysis in wild and domestic animals and man. Vet. Path. 14: 214-324.

Bassett, J. E. 1987. Hemodilution with anesthesia in the bat, *Antrozous pallidus*. J. Mammal. 68: 378-381.

Basson, P. A., and J. M. Hofmeyr. 1972. Mortalities associated with wildlife capture operations. Specialized University Course on Wildlife Capture Techniques and General Husbandry. Onderstpoort (South Africa).

Bates, J. W., and J. G. Guymon. 1985. Comparison of drive nets and darting for capture of desert bighorn sheep. Wildl. Soc. Bull. 13: 73-76.

Bauditz, R. 1972. Sedation, immobilization and anesthesia with Rompun in captive and free-living wild animals. Vet. Med. Rev. 3: 204-226.

Baumgardner, D. J., and D. A. Dewsbury. 1979. Surgical anesthesia of seven rodent species with chloral hydrate. Physiol. Beh. 23: 609-610.

Baumgartner, L. L. 1940. Trapping, handling, and marking fox squirrels. J. Wildl. Manage. 4: 444-450.

Beale, D. M., and A. D. Smith. 1967. Immobilization of pronghorn antelopes with succinylcholine chloride. J. Wildl. Manage. 31: 840-842.

Beck, C. C. 1971. Chemical restraint of exotic species. Proc. Am. Assoc. Zoo Vet. Pp. 1-81.

Beck, C. C. 1972. Chemical restraint of exotic species. J. Zoo An. Med. 3: 3-66.

Beck, C. C. 1974. Ketamine anesthesia. J. Zoo An. Med. 5: 6.

Beck, C. C. 1976. Vetalar (ketamine hydrochloride) a unique cataleptoid anesthetic agent for multispecies usage. J. Zoo An. Med. 7: 11-38.

Beck, C. C., and A. J. Dresner. 1972. Vetalar® (ketamine HCL): a cataleptoid anesthetic agent for primate species. Vet. Med. Sm. An. Clin. 67: 1082-1084.

Beeman, L. E., M. R. Pelton, and L. C. Marcum. 1974. Use of M99 etorphine for immobilizing black bears. J. Wildl. Manage. 38: 568-569.

Behrend, D. F. 1965. Notes on field immobilization of white-tailed deer with nicotine. J. Wildl. Manage. 29: 889-890.

Belant, J. L. 1991. Immobilization of fishers (*Martes pennanti*) with ketamine hydrochloride and xylazine hydrochloride. J. Wildl. Dis. 27: 328-330.

Belant, J. L. 1992. Field immobilization of American martens (*Martes americana*) and short-tailed weasels (*Mustela erminea*). J. Wildl. Dis. 28: 662-665.

Belant, J. L. 1995. Isoflurane as an inhalation anesthetic for muskrats (*Ondatra zibethicus*). J. Wildl. Dis. 31: 573-575.

Belant, J. L. 1996. Immobilization of muskrats (*Ondatra zibethicus*) with ketamine and xylazine. J. Wildl. Dis. 32: 152-155.

Bell, R. H. V., and G. L. Van Rooyen. 1985. A range-finder sight for use with capture guns. So. Afr. J. Wildl. Res. 15: 37-38.

Beltrán, J. F., M. Delibes, and C. Ibáñez. 1985. Immobilization and marking the Egyptian mongoose, *Herpestes ichneumon* (L.), in Spain. Zeitschrift für Säugertierkunde 50: 243-244.

Beltrán, J. F., and M. E. Tewes. 1995. Immobilization of oceolots and bobcats with ketamine hydrochloride and xylazine hydrochloride. J. Wildl. Dis. 31: 43-48.

Bengis, R. 1993. Chemical capture of the African buffalo *Syncerus caffer*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 583-589.

Bengis, R. G., V. de Vos,, and J. van Niekerk. 1985. Immobilization of the African elephant. Proc. 2nd Int. Congr. Vet. Anesth. Pp. 142-143.

Bennett, R. A. 1991. A review of anesthesia and chemical restraint in reptiles. J. Zoo Wildl. Med. 22: 282-303.

Bennett, R. A. 1993a. Current techniques in reptile anesthesia. Proc. No. Am. Vet. Conf. Orlando, Florida. Pp. 767-768.

Bennett, R. A. 1993b. Basic anesthesia and surgery in avian patients. Proc. No. Am. Vet. Conf. Orlando, Florida. Pp. 701-703.

Bennet, R. A. 1994. Current techniques in reptile anesthesia and surgery. Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. Pp. 36-44.

Bennett, R. R., and P. J. Tillotson. 1969. Cyclohexanone as an anesthetic for the leopard and the bengal tiger. J. Am. Vet. Med. Assoc. 155: 1098.

Bennett, R. R., F. O. Zydeck, and R. Wilson. 1971. Tiletamine anesthesia of a Siberian tiger and a lion. J. Am. Vet. Med. Assoc. 159: 620-621.

Berger, J., and M. D. Kock. 1988. Overwinter survival of carfentanil-immobilized male bison. J. Wildl. Dis. 24: 555-556.

Berger, J., M. Kock, C. Cunningham, and N. Dodson. 1983. Chemical restraint of wild horses: effects of reproduction and social structure. J. Wildl. Dis. 19: 265-268.

Bergerud, A. T., A. Butt, H. L. Russell, and H. Whalen. 1964. Immobilization of Newfoundland caribou and moose with succinylcholine chloride and Cap-Chur equipment. J. Wildl. Manage. 28: 49-53.

Berrie, P. M. 1972. Sex differences in response to phencyclidine hydrochloride in lynx. J. Wildl. Manage. 36: 994-996.

Berry, M. P. S. 1992. The tranquillization of captive red hartebeest, black wildebeest and gemsbok. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 40-43.

Bertnsen, F., T. Kvam, O. J. Sorensen, and K. Knutsen. 1994. Drug immobilization of brown bears (*Ursus arctos*). Field experience. Norsk Veterinaer. 106: 120-124.

Bertram, B. C. R. 1976. Lion immobilization using phencyclidine (Sernylan). E. Afr. Wildl. J. 14: 233-235.

Bertram, B. C. R., and J. M. King. 1976. Lion and leopard immobilization using CI-744. E. Afr. Wildl. J. 14: 237-239.

Bester, M. N. 1988. Chemical restraint of Antarctic fur seals and Southern elephant seals. So. Afr. J. Wild. Res. 18: 57-60.

Betz, T. W. 1962. Surgical anesthesia in reptiles, with special reference to the water snake, *Natrix rhombifera*. Copeia 284-287.

Beynon, P. H., and J. E. Cooper (eds.). 1991. Manual of Exotic Pets. Brit. Sm. An.

Vet. Assoc., Cheltenham. 312 pp.
Bhargava, A. K., R. B. Heath, R. L. Rudy, and A. A. Gabel. 1969. Clinical trials of halothane anaesthesia in a camel (*Camelus dromedarius*). Ind. Vet. J. 46: 999-1001.
Bienzle, D., C. J. Boyd, A. Valverde, and D. A. Smith. 1991. Sedative effects of ketamine and midazolam in snapping turtles (*Chelydra serpentina*). Vet. Surg. 20: 154.
Bienzle, D., and C. J. Boyd. 1992. Sedative effects of ketamine and midazolam in snapping turtles (*Chelydra serpentina*). J. Zoo Wildl. Med. 23: 201-204.
Bigalke, R. C. 1965. Experiments in immobilizing ungulate mammals. 1: 239-247.
Bigler, W. J., and G. L. Hoff. 1974. Anesthesia of raccoons with ketamine hydrochloride. J. Wildl. Manage. 38: 364-366.
Birnbaum, C., R. Gabler, J. Hartung, E. Schimke, and U. D. Wenzel. 1969. Halothannarkose bei Musteliden. Arch. Exp. Vet. 23: 561- 565.
Black, H. C., O. H. Hewitt, and C. W. Severinghaus. 1959. Use of drugs in handling black bears. New York Fish Game J. 6: 179-203.
Blackshaw, G. D., and B. Wakeman. 1972. Immobilization of an adult ostrich for surgery. J. Zoo An. Med. 2: 11-12.
Blake, D. K. 1993. The Nile crocodile *Crocodylus niloticus*: capture, care, accommodation, and transportation. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 654-676.
Blanchette, P. 1989. Use of halothane to anesthetize muskrats in the field. J. Wildl. Manage. 53: 172-174.
Blazhis, A. S., A. V. Mitskus, and P. P. Bluzma. 1972. [Experience of using the myorelaxant lysthenon (succinylbischoline chloride) for roe immobilization]. Liet. TSR Moksiu Akad. Darb. Ser. C. 2: 77-81.
Blumer, E. S. 1991. A review of the use of selected neuroleptic drugs in the management of nondomestic hoofstock. Proc. Am. Assoc. Zoo Vet. Pp. 333-339.
Bó, R. F., F. Palomares, J. F. Beltrán, G. de Villafañe, and S. Moreno. 1994. Immobilization of coypus (*Myocastor coypus*) with ketamine hydrochloride and xylazine hydrochloride. J. Wildl. Dis. 30: 596-598.
Boch, J., W. Nerl, P. Hunl, F. Feig. 1961. The present state of experience in the use of nicotine salicylate for capturing chamois, ibex, and red deer. Z. Jagdwiss 7: 18-25.
Boever, W. J. 1974. Injectable anesthetics in wild ruminants. Vet. Med. Sm. An. Clin. Pp. 548-550.
Boever, W. J. 1977. Restraint of exotic animals. Mod. Vet. Pract. 58: 229-232.
Boever, W. J. 1979. The restraint of non-domestic pets. Vet. Clin. North Amer. (Small Anim. Pract.). 9: 391-403.
Boever, W. J. 1986. Artiodactylids: restraint, handling, and anesthesia. *In* Fowler, M. E. (ed.). Zoo and Wild Animal Medicine. W. B. Saunders, Philadelphia. Pp. 940-952.
Boever, W. J., and H. Paluch. 1974. Injectable anesthetics in wild ruminants. Vet.

Med. Small An. Clin. 69: 548-551.

Boever, W. J., and W. Wright. 1975. Use of ketamine for restraint and anesthesia of birds. Vet. Med. Small An. Clin. 70: 86-88.

Boever, W. J., and F. Caputo. 1982. Tilazol (sic)(Cl 744) as an anesthetic agent in reptiles. J. Zoo An. Med. 13: 59-61.

Boever, W. J., D. Stuppy, and K. Kane. 1977a. Clinical experience with Telazol™ (Cl-744) as a new agent for chemical restraint and anesthesia in the red kangaroo (*Macropus rufus*). J. Zoo An. Med. 8: 14-17.

Boever, W. J., J. Holden, and K. K. Kane. 1977b. Use of Telazol™ (Cl-744) for chemical restraint and anesthesia in wild and exotic carnivores. Vet. Med. Small An. Clin. 72: 1722-1725.

Bolz, W. 1962. Neuroleptica und potenzierte Narkose speziell bei Zootieren. Nord. Vet. Med. 14, Suppl. 1: 17-29.

Bonath, K. 1979. Halothane inhalation anesthesia in reptiles and its clinical control. Int. Zoo Yb. 19: 112-115.

Bonath, K. H., P. Hauck, and D. Amelang. 1992. Die Tiletamin-Zolazepam-Immobilisation beim Wildschwein (*Sus scrofa*) und ihre bedeutung fur Gatterwild. Erkr. Zootiere 34: 179-184.

Bonath, K. H., R. D. Haller, J. Bonath, and D. Amelang. 1990. Tiletamine-zolazepam-acepromazine anesthesia in *Crocodylus niloticus* with regard to the respiratory and cardiovascular systems. Proc. 10th Work. Meet. Crocodile Spec. Group Species Survival Comm. IUCN-World Conserv. Union. 1: 8-12.

Bongso, T. A. 1979. Sedation of the Asian elephant (*Elephas maximus*) with xylazine. Vet. Rec. 105: 442-443.

Bongso, T. A. 1980. Use of xylazine for the transport of elephants by air. Vet. Rec. 107: 492.

Bongso, T. A., and B. M. A. O. Perera. 1978. Observations on the use of etorphine alone and in combination with acepromazine maleate for immobilization of aggressive Asian elephants (*Elephas maximus*). Vet. Rec. 102: 339-340.

Bonner, W. B., M. E. Keeling, E. T. Van Ormer, and J. E. Haynie. 1972. Ketamine anesthesia in chimpanzees and other great ape species. Chimpanzee 5: 255-268.

Booth, V. R., and A. M. Coetzee. 1988. The capture and relocation of black and white rhinoceros in Zimbawe. *In* Nielsen, L., and R. D. Brown (eds.). Translocation of Wild Animals. Wisconsin Humane Society, Inc., and Cesar Kleberg Wildlife Research Institute, Milwaukee, Wisconsin. Pp. 191-209.

Borchard, R. E. 1980. Evaluation of chemical restraint methods for potential use in wild, free roaming horses. Report to Bureau of Land Management , contract YA-512-CT8-116. Pullman, Wash. 16 pp.

Born, E. W., and L. Ø. Knutsen. 1990. Immobilization of Atlantic walrus (*Odobenus rosmarus rosmarus*) by use of etorphine hydrochloride reversed by diprenorphine hydrochloride. Teknisk rapport - Greenlands Hjemmestyre. Miljø og Naturforvaltning. 14.

Bornemann, H., and J. Plötz. 1993. A field method for immobilizing Weddell seals. Wildl. Soc. Bull. 21: 437-441.

Borzio, F. 1973. Ketamine hydrochloride as an anesthetic for wildfowl. Vet. Med. Small An. Clin. 68: 1364-1365.

Bose, A. S., O. Ramakrishna, N. T. Krishna Murthy, and M. Kalyanam. 1982. Anaesthesia in a porcupine during minor surgical intervention. Vet. Med. Rev. 1982: 100-103.

Boyd, I. L., N. J. Lunn, C. D. Duck, and T. Barton. 1990. Response of Antarctic fur seals to immobilization with ketamine, a ketamine-diazepam or ketamine-xylazine mixture, and Zoletil®. Marine Mamm. Sci. 6: 135-145.

Boyd, R. J. 1962. Succinylcholine chloride for immobilization of Colorado mule deer. J. Wildl. Manage. 26: 332-333.

Boyer, T. H. 1992. Clinical anesthesia of reptiles. Bull. Assoc. Amphib. Reptil. Vet. 2: 10-13.

Brannian, R. E., C. Kirk, and D. Williams. 1987. Anesthetic induction of kinosternid turtles with halothane. J. Zoo An. Med. 18: 115-117.

Brass, W. 1983. [Clinical use of psychotropic drugs in pet animals as well as in zoo and wild animals]. DTW. 90: 46-47.

Brazenor, C. W., and G. Kaye. 1953. Anaesthesia for reptiles. Copeia 1953: 165-170.

Bree, M. M. 1972. Dissociative anesthesia in *Macaca mulatta*. Clinical evaluation of CI-744. J. Med. Primatol. 1: 256-260.

Briggs, G. D., R. V. Henrickson, and B. J. Le Boeuf. 1975. Ketamine immobilization of northern elephant seals. J. Am. Vet. Med. Assoc. 167: 546-548.

Brisbin, I. L. 1966. Reactions of the American alligator to several immobilizing drugs. Copeia 1966: 129-130.

Bristol, D. G., J. Smith, and M. S. Silberman. 1984. Acepromazine and etorphine for prolonged anesthesia of a zebra. J. Am. Vet. Med. Assoc. 185: 1439-1440.

Brockelman, W. Y., and N. K. Kobayashi. 1971. Live capture of free-ranging primates with a blowgun. J. Wildl. Manage. 35: 852-855.

Brooks, C., and K. D. Morris. 1979. Blood values and the use of ketamine HCL in the fox. Vet. Med. Sm. An. Clin. 74: 1179-1180.

Brown, D. C., R. O. Mulhausen, D. J. Andrew, and U. S. Seal. 1971. Renal function in anesthetized dormant and active bears. Am. J. Phsyiol. 220: 293.

Brown, L. A. 1993. Anesthesia and restraint. *In* Stoskopf, M. K. (ed.). Fish Medicine. Saunders, Philadelphia. Pp. 79-80.

Bryon, H. T., J. F. Copeland, M. J. Schmidt, J. Olsen, and R. Hauck. 1985. Surgical approach to the abdomen of the elephant. Proc. Am. Assoc. Zoo Vet. P. 2.

Bryson, P. D. 1989. Narcotic antagonists. *In* Comprehensive Review in Toxicology. Aspen Publications, Rockville, Maryland. Pp. 339-343.

Bubenik, A. B., I. Gajic, V. Jovic, and R. Tachezy. 1967. Traitment de perdrix et de faisans par des tranquillisants du groupe des benzodiazepines. [Treatment of partridges and pheasants with benzodiazepine group tranquilizers]. Int. Congr. Game Biol. 7: 261-265.

Bubenik, A. B., and G. A. Bubenik. 1976. New, non-traumatic, disposable, automatic injection dart. Proc. Can. Assoc. Lab. An. Sci. Pp. 48-53.

Bubenik, G. A. 1982. Chemical immobilization of captive white-tailed deer and

the use of automatic blood samplers. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Milwaukee, Wisconsin: Wisconsin Humane Society, Inc. Pp. 335-354.

Bubenik, G. A., and R. D. Brown. 1989. The effect of yohimbine on plasma levels of T-3, T-4, and cortisol in xylazine-immobilized white-tailed deer. J. Zoo Wildl. Med. 92: 315-318.

Buck, N., F. Fry, C. Green, R. Gwynn, and P. Keen. 1963. The use of thiambutene, phencyclidine, hyoscine mixture for the immobilisation of the topi and the hippopotamus. Vet. Rec. 75: 630-633.

Buechner, H. K., A. M. Harthoorn, and J. A. Lock. 1959. Using drugs to control game. Wild Life 1: 49-52.

Buechner, H. K., A. M. Harthoorn, and J. A. Lock. 1960a. A new method of control of African wild animals. Nature. 185: 47-48.

Buechner, H. K., A. M. Harthoorn, and J. A. Lock. 1960b. Immobilizing Uganda kob with succinylcholine chloride. Can. J. Comp. Med. 24: 317-325.

Buechner, H. K., A. M. Harthoorn, and J. A. Lock. 1960c. Recent advances in field immobilization of large animals with drugs. Trans. North Am. Wildl. Nat. Res. Conf. 25: 415-422.

Buechner, H. K., A. M. Harthoorn, and J. A. Lock. 1960d. The immobilization of African animals in the field, with special references to their transfer to other areas. Proc. Zool. Soc. London 135: 261-268.

Buechner, H. K., A. M. Harthoorn, and J. A. Lock. 1960e. The immobilization of wild animals as an aid to management and control. Oryx 5: 346-351.

Burger, H. 1980. Modified .22 rifle ammunition for capture purposes. Br. Vet. Zool. Soc. March: 9-10.

Burke, T. J. 1986. Reptile anesthesia. *In* Fowler, M. E. (ed.). Zoo and Wild Animal Medicine. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 153-155.

Burke, T. J., and B. E. Wall. 1970. Anesthetic deaths in cobras (*Naja naja* and *Ophiophagus hannah*) with methoxyflurane. J. Am. Vet. Med. Assoc. 157: 620-621.

Burroughs, R. E. J. 1992. The opiates - a review of narcotics used for immobilization. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 54-57.

Burroughs, R. E. J. 1993a. A summary of the practical aspects of drugs commonly used for the restraint of wild animals. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 65-70.

Burroughs, R. E. J. 1993b. Principles of darting antelope and other herbivores. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 131-137.

Burroughs, R. E. J. 1993c. Chemical capture of primates. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation. Pretoria. Pp. 328-331.

Burroughs, R. E. J. 1993d. Chemical capture of antelope. *In* McKenzie, A. A.

(ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 348-380.

Burroughs, R. E. J. 1993e. Chemical capture of the warthog *Phacochoerus aethiopicus*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 621-622.

Burroughs, R. E. J. 1993f. Chemical capture of Burchell's zebra *Equus burchelli* and the mountain zebra *Equus zebra*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 627-629.

Burroughs, R. E. J., and A. A. McKenzie. 1993a. Handling, care, and loading of immobilized carnivores. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 178-183.

Burroughs, R. E. J., and A. A. McKenzie. 1993b. Handling, care, and loading of immobilized herbivores. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 184-193.

Bush, M. 1976. Giraffe restraint and immobilization. Proc. Am. Assoc. Zoo Vet. Pp. 151-154.

Bush, M. 1982. Chemical immobilization. *In* Beck, B, C. M. Wemmer, (eds.). Biology and Management of an Extinct Species, Pere David's deer. Noyes Publications. Park Ridge, New Jersey. pp. 36-38.

Bush, M. 1992. Remote drug delivery systems. J. Zoo Wildl. Med. 23: 159-180.

Bush, M. 1993. Anesthesia of high-risk animals: giraffe. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 545-547.

Bush, M., and C. W. Gray. 1972. Sterilization of projectile syringes. J. Am. Vet. Med. Assoc. 161: 672-673.

Bush, M, and V. De Vos. 1987. Observations on field immobilization of free-ranging giraffe (*Giraffa camelopardalis*) using carfentanil and xylazine. J. Zoo An. Med. 18: 135-140.

Bush, M., J. A. Moore, and L. M. Neeley. 1971. Sedation for transportation of a lowland gorilla. J. Am. Vet. Med. Assoc. 159: 546-548.

Bush, M., P. K. Ensley, K. Mehren, and W. Rapley. 1976. Immobilization of giraffes with xylazine and etorphine hydrochloride. J. Am. Vet. Med. Assoc. 169: 884-885.

Bush, M., R. Custer, J. Smeller, and L. M. Bush. 1977. Physiological measures of nonhuman primates during physical restraint and chemical immobilization. J. Am. Vet. Med. Assoc. 171: 866-869.

Bush, M., R. Custer, J. Smeller, L. M. Bush, U. S. Seal, and R. Barton. 1978. The acid-base status of lions, *Panthera leo*, immobilized with four drug combinations. J. Wildl. Dis. 4: 102-109.

Bush, M., R. S. Custer, and E. E. Smith. 1980a. Use of dissociative anesthetics for the immobilization of captive bears: blood gas, hematology and biochemical

values. J. Wildl. Dis. 16: 481-489.

Bush, M., R. Custer, and J. C. Whitla. 1980b. Hematology and serum chemistry profiles for giraffes (*Giraffa camelopardalis*): variations with age, sex, and restraint. J. Zoo An. Med. 11: 122-129.

Bush, M. J., A. M. Graves, S. J. O'Brien, and D. E. Wildt. 1990. Dissociative anaesthesia in free-ranging male koalas and selected marsupials in captivity. Austr. Vet. J. 67: 449-451.

Bush, M., S. B. Citino, and L. Tell. 1992. Telazol and Telazol/Rompun anesthesia in non-domestic cervids and bovids. Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. Pp. 252-252.

Button, C., D. G. A. Meltzer, and M. S. G. Mülders. 1981. Saffan induced poikilothermia in cheetah (*Acinonyx jubatus*). J. So. Afr. Vet. Assoc. 52: 237-238.

Campbell, H., and A. M. Harthoorn. 1963. The capture and anesthesia of the African lion in his natural environment. Vet. Rec. 75: 275-276.

Campbell, J. A. 1950. Use of anaesthesia in treatment of zoo inmates. Can. J. Comp. Med. 14: 39-41.

Calderwood, H. W. 1971. Anesthesia for reptiles. J. Am. Vet. Med. Assoc. 159: 1618-1625.

Calderwood, H. W., and E. Jacobson. 1979a. Anesthesia for reptiles. J. Am. Vet. Med. Assoc. 159: 1618-1625.

Calderwood, H. W., and E. Jacobson. 1979b. Preliminary report on the use of saffan on reptiles. Proc. Am. Assoc. Zoo Vet. Pp. 23-26.

Calle, P. P., and J. C. Bornmann. 1988. Giraffe restraint, habituation, and desensitization at the Cheyenne Mountain Zoo. Zoo Biol. 7: 243-252.

Camburn, M. A., and A. C. Stead. 1978. Anaesethesia in wild and aviary birds. J. Small An. Pract. 19: 395-400.

Cárdenas, J. C., and P. E. Cattan. 1986. Acción de xilacina como agente inmovilizante en lobos marinos (*Otaria flavescens, Arctocephalus philippi*)(Xylazine as an immobilizing agent for wild pinnipeds). Avances en Ciencias Veterinarias 1: 116-121.

Carpenter, J. W., and C. N. Hillman. 1978. Husbandry, reproduction, and veterinary care of captive ferrets. Proc. Am. Assoc. Zoo Vet. Pp. 36-47.

Carpenter, L. H., and W. R. Lance. 1983. Approved use of etorphine (M99®) in North American game animals. Rpt. Colorado Div. Wildl. 25 pp.

Carr, H. D. 1989. Immobilization of grizzlies with ketamine-xylazine and morphometrics of the bear drugged in Kananaskis Country, Alberta. Alberta Forestry-Lands-Wildlife, Fish and Wildlife Division, Wildlife Research Series 3a, 25 pp.

Carruthers, S. G., H. R. Wexler, and C. R. Stiller. 1979. Xylazine hydrochloride (Rompun) overdose in man. Clin. Toxicol. 15: 281-285.

Carter, N. 1961. Progress in drugging techniques. Wild Life 2: 9-10.

Casteel, D. A., and W. R. Edwards. 1965. Surgical anesthesia for cottontails. J. Wildl. Manage. 29:196.

Castro, M. I., J. Rose, W. Green, N. Lehner, D. Peterson, and D. Taub. 1981.

Ketamine-HCl as a suitable anesthetic for endocrine, metabolic and cardiovascular studies in *Macaca fascicularis* monkeys. Proc. Soc. Exp. Biol. Med. 168: 389-394.

Chakrabarti, K. 1980. Successful tranquilization of a sundarbans tiger. Tigerpaper. 7: 10.

Chakraborty, G. 1993. Xylazine-ketamine anaesthesia in a red panda (*Ailurus fulkgens*). Zoo's Print 8: 11.

Chalmers, G. A., and M. W. Barrett. 1977. Capture myopathy in pronghorns in Alberta, Canada. J. Am. Vet. Med. Assoc. 171: 918-923.

Chandrasekara Pillai, K. 1992. Record of behaviour of Asiatic lion on being immobilised at Nehru Zoological Park, Hyderabad. Zoo's Print 7: 18.

Channing, C. P., S. Fowler, B. Engel, and K. Vitek. 1977. Failure of daily injections of ketamine HCL to adversely alter menstrual cycle length, blood estrogen, and progesterone levels in the Rhesus monkey. Proc. Soc. Exp. Biol. Med. 155: 615-619.

Chao, C. C., R. D. Brown, and L. J. Deftos. 1984. Effects of xylazine immobilization on biochemical and endocrine values in white-tailed deer. J. Wildl. Dis. 20: 328-332.

Chapman, D. 1973. Immobilon and deer. Vet. Rec. 92: 711.

Cheney, C. S., and J. Hattingh. 1988. Effects of chemical immobilisation on the blood composition of impala (*Aepyceros melampus* Lichtenstein). J. So. Afr. Vet. Assoc. 59: 13-18.

Citino, S. B., M. Bush, and L. G. Phillips. 1984. Dystocia and fatal hyperthermic episode in a giraffe. J. Am. Vet. Med. Assoc. 185: 1440-1442.

Clarke, C. M. H., and R. J. Henderson. 1979. Evaluation of a helicopter/dart-gun technique for capturing chamois and attaching radio telemetry collars. N. Z. J. Zool. 6: 493-498.

Clarke, N. P., M. J. Huheey, and W. M. Martin. 1963. Pentobarbital anesthesia in bears. J. Am. Vet. Med. Assoc. 143: 47-51.

Clausen, B. 1994. The use of trilafon during translocation of muskoxen in west Greenland. IUCN Veterinary Specialist Group Newsletter 8: 5.

Clausen, B., P. Hjort, H. Strandgaard, and P. L. Soerensen. 1984. Immobilization and tagging of muskoxen (*Ovibus moschatus*) in Jameson Land, Northeastern Greenland. J. Wildl. Dis. 20: 141-145.

Clifford, D. H. 1958. Effect of preanesthetic medication with meperidine and promazine on barbiturate anesthesia in an ocelot and leopard. J. Am. Vet. Med. Assoc. 133: 459-463.

Clifford, D. H., C. M. Stowe, and A. L Good. 1960. Pentobarbital anesthesia in lions with special reference to preanesthetic medication. J. Am. Vet. Med. Assoc. 139: 111-116.

Clifford, D. H., A. L Good, and C. M. Stowe. 1962. Observations on the use of ataractic and narcotic preanesthesia and pentobarbital anesthesia in bears. J. Am. Vet. Med. Assoc. 140: 464-470.

Cline, D. R., and R. J. Greenwood. 1972. Effect of certain anesthetic agents on mallard ducks. J. Am. Vet. Med. Assoc. 161: 624-633.

Cline, D. R., D. B. Siniff, and A. W. Erickson. 1969. Immobilizing and collecting blood from Antarctic seals. J. Wildl. Manage. 33: 138-144.

Clutton, R. E. 1986. Prolonged isoflurane anesthesia in the golden eagle. J. Zoo An. Med. 17: 103-105.

Clutton, R. E. 1987. Anesthesia in an epileptic black bear (*Ursus americanus*): A case report and discussion of dilemma. J. Zoo An. Med. 18: 66-69.

Clutton, R. E. 1988. Inefficacy of oral ketamine for chemical restraint in turkeys. J. Wildl. Dis. 24: 380-381.

Clutton, R. E., and L. B. Duggan. 1986. Saffan anesthesia in the raccoon: a preliminary report. J. Zoo An. Med. 17: 91-99.

Clyde, V. L., P. Cardeilhac, and E. Jacobson. 1990. Chemical restraint of American alligators (*Alligator mississipiensis*) with atacurium and tiletamine-zolazepam. Proc. Am. Assoc. Zoo Vet. P. 288.

Clyde, V. L., P. Cardeilhac, and E. R. Jacobson. 1994. Chemical restraint of American alligators (*Alligator mississipiensis*) with atacurium or tiletamine-zolazepam. J. Zoo Wildl. Med. 25: 525-530.

Coetzee, H. G. J. 1964. The use of phencyclidine for immobilization of the chimpanzee. J. So. Afr. Vet. Assoc. 35: 97.

Coggins, V. L. 1975. Immobilization of Rocky Mountain elk with M99. J. Wildl. Manage. 39: 814-816.

Cohen, B. J., and M. M. Bree. 1978. Chemical and physical restraint of nonhuman primates. J. Med. Primatol. 7: 193-201.

Condy, J. B. 1964. The capture of black rhinoreros (*Diceros bicornis*) and buffalo (*Syncerus caffer*) on Lake Kariba. Rhodesian J. Agri. Res. 2: 1.

Condy, J. C. 1987. Practical aspects in the handling of African buffalo (*Syncerus caffer*). J. So. Afr. Vet. Assoc. 3: 158-159.

Conroy, P. J. 1986. Immobilizing gaur with an etorphine and tranquilizer mixture. J. Bombay Nat. Hist. Soc. 83: 499-504.

Cook, B. 1984. Chemical immobilization of black bears in Great Smoky Mountains National Park. Proc. East. Conf. Black Bear Res. Manage. 7: 79-81.

Cook, C. S., and K. K. Kane. 1980. Apparent suppression of gastrointestinal motility due to xylazine - a comparative study. J. Zoo An. Med. 11: 46-48.

Cook, R. A., and D. A. Clarke. 1984. The use of isoflurane as a general anesthetic in the Western lowland gorilla (*Gorilla g. gorilla*). Proc. Am. Assoc. Zoo Vet. Pp. 83-85.

Cook, R. A., and D. A. Clarke. 1985. The use of isoflurane as a general anesthetic in the Western lowland gorilla (*Gorilla g. gorilla*). J. Zoo An. Med. 16: 122-124.

Cooper, J. E. 1971. Surgery on a captive iguana (*Iguana iguana*). J. Zoo An. Med. 2: 29-31.

Cooper, J. E. 1974. Ketamine hydrochloride as an anaesthetic for East African reptiles. Vet. Rec. 95: 37-41.

Cooper, J. E. 1984. Anaesthesia of exotic animals. An. Technol. 35: 13-20.

Cooper, J. E. 1987. Veterinary work with non-domesticated pets. IV. Lower vertebrates. Br. Vet. J. 143: 193-202.

Cooper, J. E., and L. G. Frank. 1973. Use of the steroid anaesthetic CT 1341 in birds. Vet. Rec. 92: 474-479.

Cooper, J. E., and P. T. Redig. 1975. Unexpected reactions to the use of CT 1341 by red-tailed hawks. Vet. Rec. 97: 352.

Cooper, J. E., A. Forbes, S. Harris, and N. Chapman. 1984. Chemical restraint of deer. Vet. Rec. 114: 483.

Cooper, J. E., S. Harris, A. Forbes, N. G. Chapman, and D. I. Chapman. 1986. A comparison of xylazine and methohexitone for the chemical immobilization of Reeves' muntjac (*Muntiacus reevesi*). Br. J. Vet. 142: 350-357.

Cooper, R. M., S. R. Black, and V. Honeyman. 1992. On the use of succinycholine in elk. J. Wildl. Dis. 28: 684 (letter).

Copeland, G. L., R. E. Autenrieth, L. E. Oldenburg, and T. P. Kistner. 1978. Tranquilizing pronghorns with M-99 from a helicopter. Proc. Pronghorn Antelope Workshop 8: 94-112.

Cornell, L. 1977. Sedation of elephant seals. J. Zoo An. Med. 8: 39.

Cornell, L. H., and J. E. Antrim. 1987. Anesthesia and tusk extraction in walrus. J. Zoo An. Med. 18: 3-6.

Cornely, J. E. 1979. Anesthesia of coyotes with ketamine hydrochloride and xylazine. J. Wildl. Manage. 43: 577-579.

Cornick, J. L., and J. Jensen. 1992. Anesthetic management of ostriches. J. Am. Vet. Med. Assoc. 200: 1661-1666.

Corson, I. D., P. F. Fennessy, and J. M. Suttie. 1984. An improved design for home-made projectile syringe. N. Z. Vet. J. 32: 74-75.

Counsilman, J. W. 1954. Demorol hydrochloride as an anaesthetic for an elephant. No. Am. Vet. 35: 835-836.

Cowan, I., A. J. Wood, and H. C. Nordan. 1962. Studies in the tranquilization and immobilization of deer (*Odocoileus*). Can. J. Comp. Med. 26: 57-61.

Craighead, J. J., M. Hornocker, W. Woodgerd, and F. C. Craighead. 1960. Trapping, immobilizing and color-marking grizzly bears. Trans. No. Am. Wildl. Nat. Res. Conf. 25: 347-363.

Crawshaw, G. J., and K. G. Mehren. 1986. Use of idazoxan as an antagonist to xylazine and ketamine/xylazine sedation. *In*Scott, P. W., and A. G. Greenwood (eds.). Proc. 25th Anniv. Symp. Br. Vet. Zool. Soc. London, UK. 155 pp.

Crawshaw, G. J., K. G. Mehren, S. Black. 1986. Antagonism of xylazine and ketamine/xylazine combinations in exotic species by idazoxan and RX821002A. Proc. Am. Assoc. Zoo Vet. Pp. 1-2.

Crawshaw, P. G., and H. B. Quigley. 1989. Notes on oceolot movement and activity in the Pantanal region, Brazil. Biotropica 21: 377-379.

Cribb, P. H., and J. C. Haigh. 1977. Anaesthetics for avian species. Vet. Rec. 100: 472.

Crider, E. D., and J. C. McDaniel. 1966. Technique for capturing Canada geese with alpha-chloralose. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. Pp. 206-233.

Crider, E. D., and J. C. McDaniel. 1967. Alpha-chloralose used to capture Canada

geese. J. Wildl. Manage. 31: 258-264.

Crider, E. D., and J. C. McDaniel. 1968. Oral drugs used to capture waterfowl. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 22: 156-161.

Crider, E. D., V. D. Stotts, and J. C. McDaniel. 1968. Diazepam and alpha-chloralose mixtures to capture waterfowl. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 22: 133-141.

Crittal, J. W., and J. R. Smith. 1972. Darting of pigtail macaques (*Macaca menoestrina*) using an etorphine mixture. Vet. Rec. 14: 409-410.

Crockford, J. A., F. A. Hayes, J. H. Jenkins, S. D. Feurt. 1957a. Nicotine salicylate for capturing deer. J. Wildl. Manage. 21: 213-220.

Crockford, J. A., F. A. Hayes, J. H. Jenkins, and S. D. Feurt. 1957b. Field application of nicotine salicylate for capturing deer. Trans. No. Am. Wildl. Nat. Res. Conf. 22: 579-583.

Crockford, J. A., F. A. Hayes, J. H. Jenkins, and S. D. Feurt. 1958. An automatic projectile type syringe. Vet. Med. 53: 115-119.

Cross, J. P., C. G. MacKintosh, and J. F. T. Griffin. 1988. Effect of physical restraint and xylazine sedation on haematological values in red deer (*Cervus elephus*). Res. Vet. Sci. 45: 281-286.

Cross, J. P., Griffin, J. F. T., and C. G. MacKintosh. 1992. Influence of xylazine on hematology values in farmed red deer. *In* Brown, R. D. (ed.). The Biology of Deer. New York, Springer-Verlag. Pp. 136-140.

Cullingham, T. J. 1970. The owl monkey (*Aotus trivirgatus*) as a research animal. J. Inst. Anim. Techn. 21: 84.

Custer, R. S., and M. Bush. 1980. Physiologic and acid-base measures of gopher snakes during ketamine or halothane-nitrous oxide anesthesia. J. Am. Vet. Med. Assoc. 177: 870-874.

Custer, R. S., L. Kramer, S. Kennedy, and M. Bush. 1977. Hematologic effects of xylazine when used for restraint of Bactrian camels. J. Am. Vet. Med. Assoc. 171: 899-901.

Custer, R. S., M. Bush, J. M. Smeller, amd E. E. Smith. 1978. Clinical experience with dissociative anesthetics in lesser pandas (*Ailurus fulgens*): Hematology and blood chemistry values. J. Zoo An. Med. 9: 22-28.

Cyr, A., and R. Brunet. 1992. Anesthetization of captive red-winged blackbirds with mixtures of alpha-chloralose and secobarbital. J. Wildl. Manage. 56: 806-809.

Davis, J. R., D. C. Guynn, Jr., and B. D. Hyder. 1994. Feasibility of using tribromoethanol to recapture wild turkeys. Wildl. Soc. Bull. 22: 496-500.

David, J. M. H., J. M. Hofmyer, P. B. Best, M. A. Meyer, and P. D. Shaughnessy. 1988. Chemical immobilization of free-ranging African (Cape) fur seals. So. Afr. J. Wildl. Res. 18: 154-157.

Davy, C. W., P. N. Trennery, J. G. Edmunds, J. F. B. Altman, and D. A. Eichler. 1987. Local myotoxicity of ketamine in the marmoset. Lab. An. 21: 61-67.

Day, G. I., R. F. Dyson, and F. H. Landeen. 1965. A portable resuscitator for use on large game animals. J. Wildl. Manage. 29: 511-515.

Day, G. I., S. D. Schemnitz, and R. D. Taber. 1980. Capturing and marking wild

animals. *In* Shemnitz, S. D. (ed.). Wildlife Management Techniques Manual, The Wildlife Society, Washington, D. C. Pp. 61-88.

Day, J. 1969a. Cap-chur problems and remedies. Wildlife Digest, Arizona Game and Fish Department. 2.

Day, J. 1969b. Drug use for capturing and restraining animals. Wildlife Digest, Arizona Game and Fish Department. 4: 1.

Day, P. W. 1965. Techniques of bear anesthesia applicable to research. *In* Sawyer, D. C. (ed.). Symposium on Experimental Animal Anesthesiology. Brooks Air Force Base, Texas.

De Lamo, D. A., and J. L. Garrido. 1983. [Immobilization of guanacos *Lama guanicoe* Muller]. Cent. Nac. Patagonico Contrib. 77: 1-9.

De Meneghi, D., P. G. Meneguz, O. Abate, G. Quaranta, L. Rossi, and P. Lafranchi. 1987. Blood serum analyses of chemically captured alpine ibex, I: Values at the onset of anaesthesia. Trans. Congr. Int. Union Game Biol. Suppl. 18: 1.

De Vos, J. C., and T. Remington. 1981. A summary of capture efforts in Arizona since 1977. Desert Bighorn Council Trans. Pp. 57-59.

De Vos, V. 1978a. Immobilization of free-ranging wild animals using a new drug. Vet. Rec. 103: 64-68.

De Vos, V. 1978b. A new potent analgesic for chemical immobilization of gemsbok (*Oryx gazella gazella*). Koedoe. 21: 173-180.

De Vos, V. 1979. Do-it-yourself remote chemical immobilization equipment. Koedoe. 22: 177-186.

De Vos, V. 1985. Remote chemical immobilization of African buffalo (*Syncerus caffer*). Proc. Buffalo Symp., Pretoria, So. Afr. P. 157. (abstr.)

De Vos, V., G. L. Van Rooyen, and J. J. Kloppers. Anthrax immunization of free-ranging roan antelope *Hippotragus equinus* in the Kruger Narional Park. Koedoe 16: 11-25.

Dean, R., W. W. Hines, and D. C. Church. 1973. Immobilizing free-ranging and captive deer with phencyclidine hydrochloride. J. Wildl. Manage. 37: 82-86.

Degernes, L. A., T. J. Kreeger, R. Mandsager, and P. T. Redig. 1988. Ketamine-xylazine anesthesia in red-tailed hawks with antagonism by yohimbine. J. Wildl. Dis. 24: 322-326.

DelGiudice, G. D., L. D. Mech, W. J. Paul, and P. D. Karns. 1986. Effects on fawn survival of multiple immobilizations of captive pregnant white-tailed deer. J. Wildl. Dis. 22: 245-248.

DelGiudice, G. D., P. R. Krausman, E. S. Bellantioni, R. C. Etchberger, and U. S. Seal. 1989. Reversal by tolazoline hydrochloride of xylazine hydrochloride-ketamine hydrochloride immobilizations in free-ranging desert mule deer. J. Wildl. Dis. 25: 347-352.

DelGiudice, G. D., U. S. Seal, and T. J. Kreeger. 1988. Xylazine and ketamine-induced glycosuria in white-tailed deer. J. Wildl. Dis. 24: 317-321.

Dennig, H. K. 1972. The use of Rompun in the Dromedary in diagnostic splenectomy. Vet. Med. Rev. 4

Demaster, D. P., J. B. Faro, J. A. Estes, J. Taggart, and C. Zabel. 1981. Drug immobilization of walrus (*Odobenus rosmarus*). Can. J. Fish. Aquat. Sci. 38: 365-

367.

Denney, R. N. 1965. Immobilization and tranquilization studies on Colorado deer and elk. Colorado Game, Fish and Parks Department Job Completion Report, W-38-R18. Part I: 5-22.

Denney, R. N. 1966. Neckbanding techniques (elk) with the helicopter. Trans. W. Assoc. Game Fish Comm. 46: 134-138.

Denney, R. N. 1969. Black rhinoceros immobilization utilizing a new tranquilizing agent. E. Afr. Wildl. J. 7: 159-165.

Denney, R. N. and B. R. Gill. 1970. Annotated bibliography on mammal immobilization with drugs. Colorado Division of Game, Fish and Parks Special Report. 15. 27 pp.

Denny, M. J. S. 1973. The use of ketamine hydrochloride as a safe short duration anaesthetic in kangaroos. Br. Vet. J. 129: 362-365.

Denny, M. J. S. 1974. Anaesthesia in kangaroos and a list of anaesthetics used in monotremes and marsupials. Austral. Mammal. 1: 294-298.

Densmore, M. A. 1979. A survey of immobilization techniques used in captive sitatunga (*Tragelaphus spekei*). J. Zoo An. Med. 10: 98-102.

Densmore, M. A., M. J. Bowen, R. M. Robinson, P. G. Harms, and D. C. Kraemer. 1987. Hematologic and serum chemistry profiles of four male addax (*Addax nasomaculatus*) immobilized with etorphine and xylazine. J. Zoo An. Med. 18: 123-130.

Deresienski, D. T., and C. E. Rupprecht. 1989. Yohimbine reversal of ketamine-xylazine immobilization of raccoons (*Procyon lotor*). J. Wildl. Dis. 25: 169-174.

Des Meules, P., B. R. Simard, and J. M. Brassard. 1971. A technique for the capture of caribou, *Rangifer tarandus*, in winter. Can. Fld. Nat. 85: 221-229.

Dew, T. L. 1988. Use of tolazoline hydrochloride to reverse multiple anesthetic episodes induced with xylazine hydrochloride and ketamine hydrochloride in white-tailed deer and goats. J. Zoo An. Med. 19: 8-13.

Dewey, R. W., and A. Rudnick. 1973. An Orang Asli blowpipe with a syringe-type dart for the live capture of wild primates in Malaysia. S.E. Asian J. Trop. Med. Publ. Health 4: 285.

Dhungel, S. K. 1985. Use of Rompun (xylazine) to immobilize hog deer in Royal Chitwan National Park, Nepal. Tigerpaper. 12: 18-20.

Dickson, S. J., H. M. Stone, and E. A. Queree. 1983. Xylazine (Rompun) levels in deer antler velvet. N. Z. J. Agric. Res. 26: 93-94.

Diehl, S. R. 1988. The translocation of urban white-tailed deer. *In* Nielsen, L. and R. D. Brown (eds.). Translocation of Wild Animals. Wisconsin Humane Society, Inc., and Cesar Kleberg Wildlife Research Institute, Milwaukee, Wisconsin. Pp. 239-249.

Dieterich, R. A. 1968. The use of M-99 etorphine and its antagonist, M-285 cyprenorphine, for immobilization of wild animals. Proc. 19th Alaskan Science Conf. Abstract No. 37: 22-23.

Dieterich, R. A. 1984. Muskox medical practices. Biol. Pap. Univ. Alaska Spec. Rep. No. 4: 167-169.

Dinerstein, E., S. Shrestha, and H. Mishra. 1990. Capture, chemical immobilization, and radio-collar life for greater one-horned rhinoceros. Wildl. Soc. Bull. 18: 36-41.

Dinnes, M. R. 1982. Use of the blowpipe as an instrument for remote injection of animals. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 188-193.

Dioli, M., H. J. Schwartz, and R. Stimmelmayr. 1992. Management and handling of the camel. *In* Schwartz, M., and M. Dioli (eds.). *Camelus dromedarius* in Eastern Africa: a pictorial guide to diseases, health care, and management. Verlag Josef Margraf, Weikersheim, Germany. Pp. 62-154.

Ditman, K. S. 1964. Drug immobilization of wild animals. Mind-Psychiatry Gen. Prac. 2: 103-113, 124.

Dixon, R., J. Howes, J. Gentile, H. B. Hsu, J. Hsiao, D. Gar, D. Weidler, M. Meyer, and R. Tuttle. 1986. Nalmefene: intravenous safety and kinetics of a new opioid antagonist. Clin. Pharmacol. Ther. 39: 49-52.

Dobbs, H. E. 1968. Effects of cypronophine (M-285), a morphine antagonist, on the distribution and excretion of etorphine (M.99) a potent morphine like drug. J. Pharmacol. Exp. Therap. 160: 407-411.

Dodman, N. H. 1980. Chemical restraint in the horse. Equine Vet. J. 12: 166-170.

Doherty, T. J., and D. P. R. Tweedie. 1989. Evaluation of xylazine hydrochloride as the sole immobilizing agent in moose and caribou and its subsequent reversal with idazoxan. J. Wildl. Dis. 25: 95-98.

Dolensek, E. P. 1971. Anesthesia of exotic felines with ketamine HCl. J. Zoo An. Med. 2: 16-19.

Donahue, M. A., M. E. Lisano, and J. K. Kennamer. 1982. Effects of alpha-chloralose drugging on blood constituents in the eastern wild turkey. J. Wildl. Manage. 46: 468-474.

Done, S. H., P. Lees, O Dansie, and L. W. Watkins. 1975. Sedation and restraint of fallow deer with diazepam. Brit. Vet. J. 131: 545-548.

Dräger, N. 1974. Immobilisation von Afrikanischen Büffeln im Rahmen der Maul- und Klauenseuchebekämpfung in Botswana. Berl. Münch. Tierärztl. Wschr. 87: 328-329.

Dräger, N., L. Patterson, and D. Breton. 1976. Immobilization of African buffaloes (*Syncerus caffer caffer*) in large numbers for veterinary research. E. Afr. Wildl. J. 14: 113-120.

Drevemo, S., and L. Karstad. 1974. The effect of xylazine and xylazine-etorphine-acepromazine combination of some clinical and hematological parameters in impala and eland. J. Wildl. Dis. 10: 377-383.

Drevemo, S., J. G. Grootenhuis, and L. Karstad. 1974. Blood parameters in wild ruminants in Kenya. J. Wildl. Dis. 10: 327-334.

Duchamps, A. 1985. [Immobilization of wild animals in practice]. Trans. Congr. Int. Union Game Biol. 17: 795-802.

Dunlop, C. I., D. S. Hodgson, and E. P. Steffy. 1984. Observations during anesthetic management of an adult elephant. Proc. Ann. Meeting Am. Coll. Vet.

Anesthesiol. Pp. 1-2.

Dyson, R. F. 1965. Experience with succinylcholine chloride in zoo animals. Intl. Zoo Yb. 5: 205-206.

Eads, F. E. 1976. Tilazol™ (CI-744): a new agent for chemical restraint and anesthesia in nonhuman primates. Vet. Med. Small An. Clin. 71: 648-652.

Ebedes, H. 1962. Practical experience in the use of the Cap-Chur gun. J. So. Afr. Vet. Assoc. 33: 87-91.

Ebedes, H. 1966a. Notes on the immobilization and biology of zebra (*Equus burchelli antiquorum*) in the Etosha Game Park, S.W. Africa. J. So. Afr. Vet. Assoc. 37: 299-303.

Ebedes, H. 1966b. Gemsbok and black rhinoceros immobilization with M99. M-series, Vet. Appl. Rpt. No. 48, Reckitt and Sons, Hull, England.

Ebedes, H. 1967. Gemsbok and black rhinoceros immobilization with etorphine. M-series, Vet. Appl. Rpt. No. 57, Reckitt and Sons, Hull, England.

Ebedes, H. 1969. Notes on the immobilization of gemsbock (*Oryx gazella*) in South West Africa using etorphine hydrochloride (M99). Madoqua. 1: 35-45.

Ebedes, H. 1970. The use of sernylan as an immobilizing agent and anesthesic for wild carnivorous mammals in South West Africa. Madoqua. 2: 19-25.

Ebedes, H. 1971a. The capture of plains zebra (*Equus burchelli antiquorum*, Smith) with M.99 (Reckitt) and tranquilizers in Etosha National Park. Madoqua 3: 67-76.

Ebedes, H. 1971b. The use of sernylan to immobilize South West Africa Felidae. J. Zoo An. Med. 2: 12.

Ebedes, H. 1972. Drug immobilization of wild carnivorous animals. Onderstport (Afrique du Sud). Pp. 24-28.

Ebedes, H. 1973a. The capture of free-living vultures in the Etosha National Park with phencyclidine. J. So. Afr. Wildl. Manage. Assoc. 3: 105-107.

Ebedes, H. 1973b. The drug immobilization of carnivorous animals. *In* E. Young (ed.). The Capture and Care of Wild Animals. Human and Rouseau, Cape Town, South Africa. Pp. 62-68.

Ebedes, H. 1975a. The capture and translocation of gemsbok *Oryx gazella gazella* in the Namib Desert with the aid of fentanyl, etorphine and tranquilizers. J. So. Afr. Vet. Assoc. 46: 359-362.

Ebedes, H. 1975b. The immobilization of adult male and female elephant *Loxodonta africana* Blumenbach with etorphine and observation on the action of diprenorphine. Madoqua. 9: 19-24.

Ebedes, H. 1991. Reduce deaths with drugs. Natura 23: 15-17.

Ebedes, H. 1992a. The use of long-acting neuroleptics for translocating some South African wild animals. J. So. Afr. Vet. Assoc.

Ebedes, H. 1992b. A note on haloperidol for translocation. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 21-22.

Ebedes, H. 1993. The use of long-acting tranquilizers in captive wild animals. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 71-

99.

Ebedes, H., and J. P. Raath. 1995. The use of long term neuroleptics in the confinement and transport of wild animals. Proc. Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 173-176.

Ebedes, H., E. Leibnitz, and J. Joubert. 1977. The immobilisation of wildebeest (*Connochaetes taurinus*) with etorphine and the use of diphrenorphine as an etorphine antagonist. Madoqua. 10: 71-73.

Ebedes, H., and M Grobler. 1979. The restraint of the Cape Hunting dog *Lycaon pictus* with phencyclidine hydrochloride and ketamine hydrochloride. J. So. Afr. Vet. Assoc. 50: 113-114.

Ebedes, H., J. G. du Toit, and J. Van Rooyen. 1989. Game capture. *In* Bothma, J. du P. (ed.). Game Ranch Management. J. L. Schaik, Pretoria, South Africa. Pp. 409-483.

Ebedes, H., and R. E. J. Burroughs. 1992. Long-acting neuroleptics in wildlife. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 31-37.

Elder, W. H., and D. H. Rodgers. 1974. Immobilization and marking of African elephants and the prediction of body weight from foot circumference. Mammalia. 38: 33-53.

Elmore, R. G., D. K. Hardin, J. M. E. Balke, R. S. Younquist, and D. W. Erickson. 1985. Analyzing the effects of diazepam used in combination with ketamine. Vet. Med. Sm. An. Clin. 80: 55-57.

Eltringham, S. K. 1974. The rescue of distressed large mammals in national parks using drug immobilization. E. Afr. Wildl. J. 12: 233-238.

Engelhardt, F. R. 1977. Immobilization of harp seals, *Phoca groenlandica*, by intravenous injection of ketamine. Comp. Biochem. Physiol. 56: 75-76.

England, G. C., and R. A. Kock. 1988. The use of two mixtures of ketamine and xylazine to immobilise free ranging Bennetts wallabies. Vet. Rec. 122: 11-14.

English, A. W. 1984. Chemical restraint of deer. *In* Deer Refresher Course. Proc. Vet. Univ. Sydney, Sydney, Australia 72: 325-350.

Ensley, P. K., D. P. Launer, and J. P. Blasingame. 1984. General anesthesia and surgical removal of a tumor-like growth from the foot of a double-wattled cassowary. J. Zoo An. Med. 15: 35-37.

Enzhu, Z. 1990. Anaesthesia of cranes with ketamine hydrochloride. Chin. J. Vet. Med. 16: 28.

Erickson, A. W. 1957. Techniques for live-trapping and handling black bears. Trans. No. Am. Wildl. Nat. Res. Conf. 22: 520-543.

Eriksen, E. 1963. Om Cap-chur instrumentariet. Medlemsbl. Danske Dyrlaegeforen. 3: 53-72.

Eriksen, E. 1968a. Medikamentel immobilisering og faengsling af dyr. I. Teknik og medikamenter. Nord. Vet. Med. 20: 499-510

Eriksen, E. 1968b. Medikamentel immobilisering og faengsling af dyr. II. Indgangning af vilde knjer og hjorte. Nord. Vet. Med. 20: 576-591.

Eriksen, E. 1968c. Medikamentel immobilisering og faengsling af dyr. III.

Indgangning af vilde knjer og hjorte. Nord. Vet. Med. 20: 657-679.
Eriksen, E. 1970. Indfangning af hjortevildt ved immobilisering med neuroleptika. [Capture of cervidae by immobilization with neuroleptics]. Nord. Vet. Med. 22: 385-400.
Eriksen, E. 1976. Capture and investigation of 42 polar bears in northeast Greenland, April-May 1974. Proc. Polar Bear Spec. Group. 5: 37-47.
Eriksen, E. 1978. Medicamentous immobilization and capture of wild animals and deer. Kongelige Veterinaer. og Landbohojskole. Cophenhagen, Denmark. 198 pp.
Eriksen, E., and J. F. Hansen. 1966. Erfolge und Misserfolge bei der Anwendung von Phencylidine bei einigen Wiederkäuern und einem Elefanten. VIII Int. Symp. Erkrank. Zootiere. Leipsig. Pp. 182-188.
Escos, J., and C. L. Alados. 1993. Immobilization of Spanish ibex with etorphine plus acepromazine. Mammalia 57: 601-605.
Evans, R. R., and J. W. Goertz. 1975. Capturing wild turkeys with tribromoethanol. J. Wildl. Manage. 39: 630-634.
Faggella, A. M., and M. R. Raffe. 1987. The use of isoflurane anesthesia in a water monitor lizard and a rhino iguana. Comp. Anim. Pract. 1: 52-53.
Faggella, A. M., T. J. Kreeger, and U. S. Seal. 1986. Cardiovascular effects of xylazine HCL and ketamine HCL anesthesia in dogs and wolves. Midwest Anesthesia Conference, Univ. of Illinois, Urbana.
Fan, Z., Y. Ou, and Y. Chao. 1987. A discussion on anesthesia of the giant panda with the injection ketamine. *In* Proceedings of Therapeutics of the Giant Panda. China Forestry Publishing House. Pp. 61-65. (Chinese)
Fanton, J. W., G. B. Hubbard, and K. C. Fletcher. 1984. Halothane induced hepatic necrosis in a snow leopard. J. Zoo An. Med. 15: 108-111.
Farnsworth, R. J., and C. M. Stowe. 1976. Depression of a newborn elk calf associated with the prepartum use of etorphine hydrochloride in the dam. J. Am. Vet. Med. Assoc. 169: 888-889.
Faulkner, J. E., and A. Archambault. 1993. Anesthesia and surgery in the green iguana. Seminars in Avian Exotic Pet Med. 2: 103-108.
Feldman, D. B., and J. L. Self. 1971. Sedation and anesthesia of the Virginia opossum, *Didelphis virginiana*. Lab. An. Sci. 21: 717-720.
Felkai, F. 1993. Anaesthetization of the budgerigar by ketamine-xylazine. Magyar Allatorvosok Lapja 48: 154-155. (Hungarian)
Fenn, H. S., and C. J. Sedgwick. 1969. Immobilization and removal of retained placenta in the wild gnu (wildebeest). Clif. Vet. 23: 17-18.
Ferin, M., P. W. Carmel, M. P. Warren, R. L. Himsworth, A. G. Frantz, and M. R. Nocenti. 1976. Phencyclidine sedation as a technique for handling rhesus monkeys: effects on LH, GH, and prolactin secretions. Proc. Soc. Exp. Biol. Med. 151: 428-433.
Ferney, J. 1966. Del'emploi de la carabine Cap-shur Palmer pour les injections a distance chez les animaux. Bull. Soc. Sci. Vet. et Med. comparee, Lyon. 68: 7-426.
Ferreras, P., J. J. Aldama, J. F. Beltràn, and M. Delibes. 1994. Immobilization of

the endangered Iberian lynx with xylazine- and ketamine-hydrochloride. J. Wildl. Dis. 30: 65-68.

Fessel, L. 1971. Zur Sedation und Immobilisation von Wildtieren. Wien. Tierärztl. Mschr. 58: 179-185.

Fessel, L. 1972. Zur medikamentoesen immobilisation von Wildtieren. [On the medical immobilization of wild animals]. Z. Jagdwiss. 18: 15-23.

Festa-Bianchet, M., and J. T. Jorgenson. 1985. Use of xylazine and ketamine to immobilize bighorn sheep in Alberta. J. Wildl. Manage. 49: 162-165.

Feurt, S. D., J. H. Jenkins, F. A. Hayes, and J. A. Crockford. 1958. Pharmacology and toxicology of nicotine with special reference to species variation. Science 127: 1054-1055.

Fiala, L., P. Guba, and M. Hojovcova. 1984. [Controlled respiration of exotic animals - its use in anaesthesia]. Proc. Int. Symp. Dis. Zoo. Anim. 26: 205-206.

Field, W. E., J. Yelnosky, J. Mundy, and J. Mitchell. 1966. Use of droperidol and fentanyl for analgesia and sedation in primates. J. Am. Vet. Med. Assoc. 149: 896-901.

Finer, B. L. 1954. Anaesthesia of the common seal. Anaesthesia 9: 34.

Finnie, E. P. 1976. Restraint and anaesthesia in monotremes and marsupials. Proc. Post-Grad. Committee in Vet. Sci., U. Sydney. 29: 49-52.

Finnie, E. P. 1986. Restraint: monotremes and marsupials. *In* Fowler, M. E. (ed.). Zoo and Wild Animal Medicine, 2nd ed. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp 570-572.

Firn, S. 1973. Accidental poisoning by an animal immobilizing agent. The Lancet 2: 95-96.

Fisher, L. E. 1965. General and chemical restraint technics used in a zoological garden. *In* Sawyer, D. C. (ed.). Symposium on Experimental Animal Anesthesiology. Brooks Air Force Base, Texas.

Fitzgerald, G. 1993. Effect of nitrous oxide on the minimal anaesthetic dose of isoflurane in the pigeon and red-tailed hawk. Med. Vet. Quebec. 23: 132.

Fitzgerald, J. P. 1973. Four immobilizing agents used on badgers under field conditions. J. Wildl. Manage. 37: 8-421.

Flamand, J. R. B., and D. Lawson. 1986. Capture and care of suni (*Neotragus moschatus*) in Natal. Lammergeyer. 37: 36-39.

Flamand, J. R. B., and P. S. Rogers. 1992. The tranquillization of reedbuck and nyala. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 47-48.

Flamand, J. R. B., K. Rochat, and M. E. Keep. 1984. Instruction guide to the most commonly and most successfully used methods in rhino capture, handling, transport, and release. *In* Corfield, T. (ed.). The Wilderness Guardian. Nairobi Space Publishers, Nairobi. Pp. 546-584.

Flamand, J. R. B., P. S. Rogers, and D. K. Blake. 1992. Immobilization of crocodiles. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 61-65.

Flecknell, P. A., M. John, M. Mitchell, and C. Shurey. 1983. Injectable anaesthetic techniques in two species of gerbil (*Meriones libycus* and *Meriones*

unguiculatus). Lab. An. 17: 118-128.

Fletch, A. L., G. Wobeser, and L. Karstad. 1967. The use of etorphine (M.99) and cyprenorphine (M.285) for immobilizing of white-tailed deer (*Odocoileus virginianus*). Unpublished report F.A.O.

Fletcher, J. 1974. Hypersensitivity of an isolated population of red deer (*Cervus elaphus*) to xylazine. Vet. Rec. 94: 85-86.

Fletcher, J. 1995. Handling farmed deer. In Practice 17: 30-37.

Fletcher, K. C. 1980. Needle reinforcement of butane powered darts. J. Zoo An. Med. 11: 44-46.

Fletcher, K. C., L. Boyce, and D. Florence. 1979. Butane powered injection by pole syringe. J. Zoo An. Med. 10: 106-112.

Fletcher, T. J. 1986. Sedation and immobilization. *In* Alexander, T. L. (ed.). Management and Diseases of Deer. Veterinary Deer Society, London, U.K. Pp. 57-59.

Flook, D. R., J. R. Robertson, O. R. Hermanrude, and H. K. Buechner. 1962. Succinylcholine chloride for immobilization of North American elk. J. Wildl. Manage. 26: 334-336.

Flyger, V., M. S. R. Smith, R. L. Damm, and R. S. Peterson. 1965. Effects of three immobilizing drugs on Weddell seals. J. Mammal. 46: 345-347.

Flyger, V., M. W. Schein, A. W. Erickson, and I. Larsen. 1967. Capturing and handling polar bears: a progress report on polar bear ecological research. Trans. No. Am. Wildl. Nat. Res. Conf. Pp. 107-119.

Fong, D. W. 1982. Immobilization of caribou with etorphine plus acepromazine. J. Wildl. Manage. 46: 560-562.

Forsythe, D. B., A. J. Payton, D. Dixon, P. H. Myers, J. A. Clark, and J. R. Snipe. 1992. Evaluation of Telazol-xylazine as an anesthetic combination for use in Syrian hamsters. Lab. An. Sci. 42: 497-502.

Foster, J. W. 1974. Case reports from preliminary investigations of a new tranquilizer. World's Cats. 2: 228-236.

Foster, P. A. 1973. Immobilization and anaesthesia of primates. *In* E. Young (ed.). The Capture and Care of Wild Animals. Human and Rouseau, Cape Town, South Africa. Pp. 69-76.

Fowler, M. E. 1978a. Restraint and handling of wild and domestic animals. Iowa State University Press, Ames Iowa.

Fowler, M. E. (ed.). 1978b. Zoo & Wild Animal Medicine. W. B. Saunders Company, Philadelphia, Pennsylvania. 951 pp.

Fowler, M. E. 1981a. Immobilization of caribou with etorphine plus acepromazine. Proc. Am. Assoc. Zoo Vet. Pp. 87-91.

Fowler, M. E. 1981b. Problems with immobilizing and anesthetizing elephants. Proc. Am. Assoc. Zoo Vet. Pp. 87-91.

Fowler, M. E. 1982. Delivery systems for chemical immobilization. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Human Society Inc., Milwaukee, Wisconsin. Pp. 18-45.

Fowler, M. E. (ed.). 1986. Zoo & Wild Animal Medicine. Second edition. W. B.

Saunders Company, Philadelphia, Pennsylvania. 1127 pp.
Fowler, M. E. 1988. Medicine and Surgery of South American Camelids. Iowa State University Press, Ames Iowa.
Fowler, M. E. (ed.). 1993. Zoo & Wild Animal Medicine. Current Therapy 3. W. B. Saunders Company, Philadelphia, Pennsylvania. 617 pp.
Fowler, M. E., and R. Hart. 1973. Castration of the Asian elephant using etorphine anesthesia. J. Am. Vet. Med. Assoc. 163: 539-541.
Frank, L. G., and J. E. Cooper. 1974. Further notes on the use of CT 1341 in birds of prey. Raptor Res. 8: 29-32.
Franzmann, A. W. 1982. An assessment of chemical immobilization of North American moose. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc., Milwaukee, Wisconsin. Pp. 393-407.
Franzmann, A. W., and E. T. Thorne. 1970. Physiological values in wild bighorn sheep (*Ovis canadensis canadensis*) at capture, after handling, and after captivity. J. Am. Vet. Med. Assoc. 157: 647-650.
Franzmann, A. W., and P. D. Arneson. 1974. Immobilization of Alaskan moose. J. Zoo An. Med. 5: 26-32.
Franzmann, A. W., and W. R. Lance. 1988. Chemical immobilization of wildlife: recent advances. *In* Nielsen, L., and R. D. Brown (eds.). Translocation of Wild Animals. Wisconsin Humane Society, Inc., and Cesar Kleberg Wildlife Research Institute, Milwaukee, Wisconsin. Pp. 99-109.
Franzmann, A. W., A. Flynn, and P. D. Arneson. 1975. Serum corticoid levels relative to handling stress in Alaskan moose. Can. J. Zool. 53: 1424-1426.
Franzmann, A. W., C. C. Schwartz, and D. C. Johnson. 1982. Chemical immobilization of moose at the Moose Research Center, Alaska (1968-1981). Alces. 18: 94-115.
Franzmann, A. W., C. C. Schwartz, D. C. Johnson, and J. B. Faro. 1984. Immobilization of moose with carfentanil. Alces. 20: 259-281.
Franzmann, A. W., C. C. Schwartz, and D. C. Johnson. 1987. Anesthesia of moose for vasectomy using carfentanil/xylazine and reversal with naloxone/yohimbine. Alces. 23: 221-226.
Fredrickson, L. F., and C. G. Trautman. 1974. Use of stupefacient and tranquilizer drugs for capturing and handling pheasants, 1967-1973, South Dakota. South Dakota Dept. Game, Fish, and Parks, P-R Project W-75-R-16, Study No. P-10.2-16-1, Pierre, So. Dakota. 31 pp.
Fredrickson, L. F., and C. G. Trautman. 1978. Use of drugs for capturing and handling pheasants. J. Wildl. Manage. 42: 690-693.
Freed, D., and B. Baker. 1989. Antagonism of xylazine hydrochloride sedation in raptors by yohimbine hydrochloride. J. Wildl. Dis. 25: 136-138.
Freeman, R. R. 1986. Pre-anesthetic, anesthetic and post-anesthetic care for raptors. Wildl. J. 9: 3-6.
Frye, F. L. 1981. Biomedical and Surgical Aspects of Captive Reptile Husbandry. Vet. Med. Publ. Co., Edwardsville, Kansas. Pp. 241-246.
Frye, F. L. 1991. Anesthesia. *In* Frye, F. L. (ed.). Biomedical and Surgical Aspects

of Captive Reptile Husbandry. Krieger, Malabar, Florida. Pp. 421-437.

Fuhrman, F. A., and E. T. Stuhr. 1941. Pentobarbital sodium as an anesthetic for minks. J. Am. Vet. Med. Assoc. 98: 43- 44.

Fuller, G. B., W. C. Hobson, F. I. Reyes, J. S. D. Winter, and C. Faiman. 1984. Influence of restraint and ketamine anesthesia on adrenal steroids, progesterone, and gonadotropins in rhesus monkeys. Proc. Soc. Exp. Biol. Med. 175: 487-490.

Fuller, T. K., and L. B. Keith. 1981. Immobilization of wolves in winter with etorphine. J. Wildl. Manage. 45: 271-273.

Fuller, T. K., and D. W. Kuehn. 1983. Immobilization of wolves using ketamine in combination with xylazine or promazine. J. Wildl. Dis. 19: 69-72.

Fuller, T. K., K. D. Kerr, and P. D. Karns. 1985. Hematology and serum chemistry of bobcats in north central Minnesota. J. Wildl. Dis. 21: 29-32.

Fuller, T. K., A. R. Biknevicus, and P. W. Kat. 1990. Movements and behavior of large spotted genets (*Genetta maculata* Gray 1830) near Elmenteita, Kenya (Mammalia Viverridae). Trop. Zool. 3: 13-19.

Furley, C. W. 1986. Effect of chemical immobilisation on the heart rate and haematological values in captive gazelles. Vet. Rec. 118: 178-180.

Gage, L. J. 1984. Restraint and anesthesia in pinnipeds. Proc. Am. Assoc. Zoo Vet. P. 31.

Gage, L. J. 1993. Pinniped anesthesia. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 412-413.

Gales, N. J. 1984. Ketamine HCl and diazepam anesthesia of a leopard seal (*Hydrurga leptonyx*) for the biopsy of multiple fibromatous epulis. Aust. Vet. J. 61: 295-296.

Gales, N. J. 1989. Chemical restraint and anesthesia of pinnipeds: a review. Mar. Mamm. Sci. 5: 228-256.

Gales, N. J., and H. R. Burton. 1987. Prolonged and multiple immobilizations of the Southern elephant seal using ketamine hydrochloride-xylazine hydrochloride or ketamine hydrochloride-diazepam combinations. J. Wildl. Dis. 23: 614-618.

Gales, N. J., and H. R. Burton. 1988. Use of emetics and anaesthesia for dietary assessment of Weddell Seals. Austr. Wildl. Res. 15: 423-433.

Gallagher, J. F., R. L. Lochmiller, and W. E. Grant. 1985. Immobilization of collared peccaries with ketamine hydrochloride. J. Wildl. Manage. 49: 356-357.

Gallanosa, A. C., D. A. Spyker, J. R. Shipe, and D. L. Morris. 1981. Human xylazine overdose: a comparative review with clonidine, phenothiazines, and tricyclic antidepressants. Clin. Toxicol. 18: 663-678.

Gandal, C. P. 1967. Drugs used in the zoo. Fed. Proc. 26: 1247-1250.

Gandal, C. P. 1968. A practical anesthetic technique in snakes, utilizing methoxyflurane. J. Am. Anim. Hosp. 4: 258-260.

Gandini, G. C. M., R. H. Keffen, R. E. J. Burroughs, and H. Ebedes. 1986. An anaesthetic combination of ketamine, xylazine and alphaxalone-alphadolone in ostriches. Vet. Rec. 118: 729-730.

Gandini, G. C. M., H. Ebedes, and R. E. J. Burroughs. 1989. The use of long-acting neuroleptics in impala (*Epicures melampus*). J. So. Afr. Vet. Assoc. 60: 206-207.

Garcia-Villar, R., P. L. Toutain, M. Alvinerie, and Y. Ruckebusch. 1981. The pharmacokinetics of xylazine hydrochloride: an interspecific study. J. Vet. Pharmacol. Therap. 4: 87-92.

Garner, D. L., and E. M. Addison. 1994a. Postpartum immobilization of adult female moose using xylazine, ketamine, and yohimbine hydrochloride. J. Wildl. Dis. 30: 123-125.

Garner, D. L., and E. M. Addison. 1994b. Postpartum immobilization of adult female moose using xylazine, ketamine, and yohimbine hydrochloride. Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. Pp. 123-125.

Garruthers, S. C., M. Nelson, C. R. Stiller, and H. R. Stiller. 1979. Xylazine hydrochloride (Rompun) overdose in man. Clin. Toxicol. 15: 281-285.

Garshelis, D. L., K. V. Noyce, and P. D. Karns. 1987. Yohimbine as an antagonist to ketamine-xylazine immobilization of black bears. Int. Conf. Bear Res. and Manage. 6.

Garver, B. H., and L. L. Jackson. 1985. Restraint and anaesthesia of uncommon veterinary patients. Iowa State Univ. Vet. 47: 46-53.

Gasaway, W. C., A. W. Franzmann, and J. B. Faro. 1978. Immobilizing moose with a mixture of etrophine and xylazine hydrochloride. J. Wildl. Manage. 42: 686-690.

Gass, H. 1970. Parke-Sernyl (Phencyclidine) used in lions. Kleintier-Praxis 15: 66.

Gates, J. B. 1972. A report of halothane anesthesia in a camel. J. Zoo An. Med. 2: 26-27.

Gatesman, T., and H. Wiesner. 1982. Immobilization of polar (*Thalarctos maritimus*) and brown (*Ursus arctos*) bears using etorphine and xylazine. J. Zoo An. Med. 13: 11-18.

Gaukler, A., and M. Kraus. 1970. Zur immobilization von Wildwiederkäuern mit Xylazin (Bay Va 1470). Der Zoologische Garten. 38: 37-46.

Gavier, M. D., M. Kittleson, M. E. Fowler, L. Johnson, G. Hall, and D. Nearenberg. 1986. Evaluation of xylazine, ketamine hydrochloride and halothane for anaesthesia in llamas. Proc. Am. Assoc. Zoo Vet. P. 127.

Gaynor, B., and S. Haigh. 1992. Rhinoceros anaesthesia. Austral. Reg. Assoc. Zool. Parks Aquaria. 7: 3-4.

Geiger, G. 1976. Combination of Rompun (xylazine) and Valium (diazepam) for the immobilization of fallow deer. Praktische Tierarzt. 57: 830-833.

Geiser, D. R., P. J. Morris, and H. S. Adair. 1992. Multiple anesthetic events in a reticulated giraffe (*Giraffa camelopardalis*). J. Zoo Wildl. Med. 23: 189-196.

Genevois, J. P., A. Autefage, P. Fayolle, A. Cazieux, and P. Bonnemaison. 1983a. [Anaesthesia of unusual species in common veterinary practice. Note 1. Fishes and reptiles anaesthesia]. Rev. Med. Vet. (Toulouse). 134: 471-479.

Genevois, J. P., A. Autefage, P. Fayolle, A. Cazieux, and P. Bonnemaison. 1983b. [Anaesthesia of unusual species in common veterinary practice. Note 2. Birds

anaesthesia]. Rev. Med. Vet. (Toulouse). 134: 601-607.

Genevois, J. P., A. Autefage, P. Fayolle, A. Cazieux, and P. Bonnemaison. 1984a. [Anaesthesia of unusual species in common veterinary practice. Note 3. Rabbit and rodents anaesthesia]. Rev. Med. Vet. (Toulouse). 135: 273-279.

Genevois, J. P., P. Fayolle, A. Autefage, P. Bonnemaison, and A. Cazieux. 1984b. [Anaesthesia of unusual species in common veterinary practice. Note 4. Wild carnivora anaesthesia]. Rev. Med. Vet. (Toulouse). 135: 379-384.

Gentry, R. L., and J. H. Johnson. 1978. Physical restraint for immobilizing fur seals. J. Wildl. Manage. 42: 944-946.

Gentry, R. L., and J. R. Holt. 1982. Equipment and techniques for handling northern fur seals. U.S. Dept. Commerce, NOAA Tech. Rpt., NMFS SSRF-758.

Geraci, J. R. 1973. An appraisal of ketamine as an immobilizing agent in wild and captive pinnipeds. J. Am. Vet. Med. Assoc. 163: 574-577.

Geraci, J. R., K. Skirnisson, and D. J. St. Aubin. 1981. A safe method for repeatedly immobilizing seals. J. Am. Vet. Med. Assoc. 179: 1192-1193.

Gibeau, M. L., and P. C. Paquet. 1991. Evaluation of Telazol for immobilization of black bears. Wildl. Soc. Bull. 19: 400-402.

Gibson, D. F., A. Oelschlaeger, P. F. Scanlon, and R. L. Kirkpatrick. 1979. Some reactions of white-tailed deer to xylazine hydrochloride. Va. J. Sci. 30: 48.

Gibson, D. F., P. F. Scanlon, R. J. Warren, A. Oelschlaeger, and R. L. Kirkpatrick. 1980a. Dose rates of xylazine hydrochloride (Rompun) for the immobilization of white-tailed deer. Va. J. Sci. 31: 99.

Gibson, D. F., P. F. Scanlon, and R. L. Kirkpatrick. 1980b. Effects of xylazine hydrochloride (Rompun) on respiration rates and rectal temperatures of white-tailed deer. Va. J. Sci. 31: 98.

Gibson, D. F., P. F. Scanlon, and R. J. Warren. 1982. Xylazine hydrochloride for immobilizing captive white-tailed deer (*Odocoileus virginianus*). Zoo Biol. 1: 311-322.

Gilbert, F. F. 1976. Impact energy thresholds for anesthetized raccoons, mink, muskrats, and beavers. J. Wildl. Manage. 40: 669-676.

Gilbert, P. W., and F. G. Wood. 1957. Method of anesthetizing large sharks and rays safely and rapidly. Science. 126: 212-213.

Gillespie, D., and C. Adams. 1985. Anatomy, husbandry, and anesthesia of the giant anteater (*Myrmecophaga tridactyla*). Proc. Am. Assoc. Zoo Vet. Pp. 35-36.

Gillingham, J. C., D. L. Clark, and G. R. Ten Eyck. 1983. Venomous snake immobilization: a new technique. Herpetol. Rev. 14: 40.

Gilroy, B. A., and J. S. Varga. 1980. Use of ketamine-diazepam and ketamine-xylazine combinations in guinea pigs. Vet. Med. Sm. An. Clin. 75: 508-509.

Glander, K. E., L. M. Fedigan, L. Fedigan, and C. Chapman. 1991. Capture techniques for three species of monkeys in Costa Rica. Folia Primatologica 57: 70-82.

Glenn, J. L., R. Straight, and C. C. Snyder. 1972a. Clinical use of ketamine hydrochloride as an anesthesic agent for snakes. Am. J. Vet. Res. 33: 1901-1903.

Glenn, J. L., R. Straight, and C. C. Snyder. 1972b. Ketalar - a new anaesthetic for

use in snakes. Int. Zoo Yb. 12: 224-226.

Glover, G. J., D. G. Larson, and J. C. Haigh. No Date. Immobilization of moose (*Alces alces*) using combinations of carfentanil, fentanyl, and xylazine. Glover Wildlife Veterinary Services, Box 880, Stonewall, Manitoba.

Goetz, R. H. 1955. Curare "spiked" bullet in giraffe. Time. 66: 65.

Golightly, R. T. Jr., and T. D. Hofstra. 1989. Immobilization of elk with a ketamine-xylazine mix and rapid reversal with yohimbine hydrochloride. Wildl. Soc. Bull. 17: 53-58.

Göltenboth, R. 1988. Zum aktuellen Stand der Immobilisation der Zootiere. Deutsche Tierärztliche Wochenschrift 95: 402-403.

Göltenboth, R., and H.-G. Klös. 1970. Application of Rompun for the immobilization of zoo animals. Berliner Muenchener Tierarztliche Wochenschrift. 83: 147-151.

Göltenboth, R., and H.-G. Klös. 1976. Zur Immobilisation von Zootieren mit Vetelar und Rompun. 18th Int. Symp. Dis. Zoo and Wild An. Innsbruck. Pp. 287-293.

Göltenboth, R., and H.-G. Klös. 1987. Versuche mit Yohimbin als Antidot bei durch Xylazin (Rompun®) Immobilisierten Zootieren im Zoo Berlin. 29th Int. Symp. Dis. Zoo and Wild An. Pp 143-149.

Gonzales, B. J., and T. McDonnel. 1986. The effects of yohimbine on xylazine-ketamine anesthesia in exotic felidae. Proc. Am. Assoc. Zoo Vet. Pp. 142-143.

Goodrich, P. G. E. 1977. Accidental self injection. Vet. Rec. 100: 458-459.

Goosen, D. J., J. H. Davies, M. Maree, and I. C. Dormehl. 1984. The influence of physical and chemical restraint on the physiology of the chacma baboon (*Papi ursinus*). J. Med. Primatol. 13: 339-351.

Gordon, B. 1977. The use of sodium amobarbital for waterfowl capture. J. Zoo An. Med. 8: 34-35.

Gordon, D. F. 1966. A brief history of drug capture. Colorado Game, Fish and Parks. 36: 4 pp.

Graham, D. L., R. H. Dunlop, and H. F. Travis. 1967. Barbiturate anesthesia in ranch mink (*Mustela vison*). Am. J. Vet. Res. 28: 293-296.

Graham-Jones, O. 1964. Restraint and anesthesia of some captive wild animals. Vet. Rec. 76: 1216-1248.

Gray, C. W. 1974. Immobilization of the bongo (*Boocercus eurycerus*). J. Zoo An. Med. 5: 19-20.

Gray, C. W., and A. P. W. Nettashinghe. 1970. A preliminary study on the immobilization of the Asiatic elephant (*Elephas maximus*) utilizing etorphine (M-99). Zoologica. 55: 51-54.

Gray, C. W., M. Bush, and C. C. Beck. 1974. Clinical experience using CI-744 in chemical restraint and anesthesia of exotic specimens. J. Zoo An. Med. 5: 12-21.

Green, B. 1976. The use of etorphine hydrochloride (M99) in the capture and immobilization of wild dingoes, *Canis familiaris dingo*. Austral. Wildl. Res. 3: 123-128.

Green, C. J. 1978. Anesthetizing ferrets. Vet. Rec. 102: 269.

Green, C. J., J. Knight, S. Precious, and S. Simpkin. 1981. Ketamine alone and

combined with diazepam or xylazine in laboratory animals: a 10-year experience. Lab. An. 15: 163-170.

Green, H. 1963. New technique for using the Cap-Chur gun. J. Wildl. Manage. 27: 292-296.

Green, M. J. B. 1986. Immobilization of Himalayan musk deer, *Moschus chrysogaster*, in captivity using ketamine and xylazine. J. Zoo An. Med. 17: 56-58.

Greene, S. A. 1988. Capture and anesthetic techniques for deer and elk. Southwest Vet. 38: 11-15.

Greene, S. A., and J. C. Thurmon. 1988. Xylazine – a review of its pharmacology and use in veterinary medicine. J. Vet. Pharmacol. Ther. 11: 295-313.

Greenwood, A. G., and D. C. Taylor. 1983. Anesthesia in seals. Vet. Rec. 113: 303.

Gregg, D. A., and L. D. Olson. 1975. The use of ketamine hydrochloride as an anesthetic for raccoons. J. Wildl. Dis. 11: 335-337.

Greth, A., M. Vassart, and S. Anagariyah. 1993. Evaluation of medetomidine-induced immobilization in Arabian oryx (*Oryx leucoryx*): clinical, hematologic and biochemical effects. J. Zoo Wildl. Med. 24: 445-453.

Greth, A., M. Vassart, and S. Anagariyah. 1993. Chemical immobilization in gazelles, *Gazell sp*, with fentanyl and azaperone. Afr. J. Ecol. 31: 6674.

Griffiths, D., Ø. Wiig, and I. Gjertz. 1993. Immobilization of walrus with etorphine hydrochloride and Zoletil. Mar. Mamm. Sci. 9: 250-257.

Grobler, J. H., and J. H. Van der Meulen. 1975. The capture of sable, *Hippotragus niger niger* (Harris, 1838), using etorphine hydrochloride (M99), Rompun (VA 1470) and chlorpromazine hydrochloride. Arnoldia (Rhod.). 7: 1-14.

Grootenhuis, J. G., L. Karstad, and S. A. Drevemo. 1976. Experience with drugs for capture and restraint of wildebeest, impala, eland and hartebeest in Kenya. J. Wildl. Dis. 12: 435-443.

Gullett, P. A. 1984. Use of yohimbine to reverse chemical immobilization in selected California ungulates. Proc. Am. Assoc. Zoo Vet. P. 58.

Gyuris, E., and C. J. Limpus. 1989. Rapid method for immobilization and collection of sea turtle muscle biopsies for electrophoresis. Aust. Wildl. Res. 13: 333-334.

Hackenbrock, C. R., and M. Finster. 1963. Fluothane: a rapid and safe inhalation anesthetic for poisonous snakes. Copeia 2: 440-441.

Hagenbeck, C. C., H. Linder, and D. Weber. 1975. Fiberoptic gastroscopy in an anaesthetized walrus (*Odobenus rosmarus*). Aquat. Mamm. 3: 20-22.

Haigh, J. C. 1976a. Some mechanical faults associated with dart immobilization. J. Zoo An. Med. 7: 12-14.

Haigh, J. C. 1976b The immobilisation of the bongo (*Boocercus eurycus*) and other African antelopes in captivity. Vet. Rec. 98: 237-239.

Haigh, J. C. 1976c. The use of CT1341 for surgical anesthesia in a pelican. J. Zoo An. Med. 7: 39.

Haigh, J. C. 1976d. Fentanyl-based mixtures in exotic animal neuroleptanalgesia. Proc. Am. Assoc. Zoo Vet. Pp. 164-180.

Haigh, J. C. 1976e. An extra tool for medication of exotic or dangerous animals.

Proc. Am. Assoc. Zoo Vet. Pp. 249-260.
Haigh, J. C. 1977a. Fallow deer immobilisation with fentanyl and a neuroleptic. Vet. Rec. 100: 386-387.
Haigh, J. C. 1977b. The capture of wild black rhinoceros using fentanyl and azaperone. So. Afr. J. Wildl. Res. 7: 11-14.
Haigh, J. C. 1978a. Freeze-dried ketamine and Rompun for use in exotic species. Proc. Am. Assoc. Zoo Vet. Pp. 21-23.
Haigh, J. C. 1978b. Use and abuse of drugs for chemical restraint of wildlife. Vet. Clin. North Am. 8: 343-352.
Haigh, J. C. 1978c. Capture of woodland caribou in Canada. Proc. Am. Assoc. Zoo Vet. Pp. 110-115.
Haigh, J. C. 1979. Hyaluronidase as an adjunct in an immobilizing mixture for moose. J. Am. Vet. Med. Assoc. 175: 916-917.
Haigh, J. C. 1981. Anaesthesia of raptorial birds. 1980. *In* Cooper, J. E., A. G. Greenwood (eds.). Recent Advances in the Study of Raptor Diseases. Proceedings of the International Symposium on Diseases of Birds of Prey. London. Pp. 61-66.
Haigh, J. C. 1982. Mammalian immobilizing drugs: their pharmacology and effects. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 46-62.
Haigh, J. C. 1987a. Yohimbine and physostigmine as antidotes to xylazine in elk (*Cervus elaphus*). J. Zoo An. Med. 18: 70-72.
Haigh, J. C. 1987b. Naltrexone HCL in zoological medicine–a preliminary report. Proc. 1st Int. Conf. Zool Avian Med., Oahu, Hawaii. Omnipress, Madison, Wisconsin. P. 529.
Haigh, J. C. 1988. Misuse of xylazine. Can. Vet. J. 29: 782-784.
Haigh, J. C. 1989. Hazardous drugs in zoo and wildlife medicine. Proc. Am. Assoc. Zoo Vet. Pp. 69-71.
Haigh, J. C. 1990a. Opioids in zoological medicine. J. Zoo Wildl. Med. 21: 391-413.
Haigh, J. C. 1990b. Immobilization of wapiti with carfentanil and xylazine. 2nd Intl. Wildl. Ranching Symp., Edmonton, Alberta, Canada.
Haigh, J. C. 1991. Immobilization of wapiti with carfentanil and xylazine and opioid antagonism with diprenorphine, naloxone, and naltrexone. J. Zoo Wildl. Med. 22: 318-323.
Haigh, J. C. 1993. Low-dose carfentanil together with xylazine in wapiti. Proc. Am. Assoc. Zoo Vet. P. 146.
Haigh, J. C., and H. C. Hopf. 1976. The blowgun in veterinary practice: its uses and preparation. J. Am. Vet. Med. Assoc. 169: 881-883.
Haigh, J. C., and R. E. A. Stewart. 1979. Narcotics in hooded seals (*Cystophora cristata*): a preliminary report. Can. J. Zool. 57: 946-949.
Haigh, J. C., and J. M. Haigh. 1980. Immobilizing drug emergencies in humans. Vet. Human Toxicol. 22: 94-98.
Haigh, J. C., and R. Alsager. 1987. Yohimbine and physostigmine as antidotes to

xylazine in elk (*Cervus elaphus*) J. Zoo Anim. Med. 18: 70-72.

Haigh, J. C., and R. J. Hudson. 1993. Farming Wapiti and Red Deer. Mosby, St. Louis. Pp. 83-98.

Haigh, J. C., and C. C. Gates. 1995. Capture of wood bison (*Bison bison athabascae*) using carfentanil-based mixtures. J. Wildl. Dis. 37-42.

Haigh, J. C., R. F. Stewart, G. Wobeser, and P. S. MacWilliams. 1977. Capture myopathy in moose. J. Am. Vet. Med. Assoc. 171: 924-926.

Haigh, J. C., R. Stewart, R. Frokjer, and T. Hauge. 1977. Capture of moose with fentanyl and xylazine. J. Zoo An. Med. 8: 22-29.

Haigh, J. C., I. S. C. Parker, D. A. Parkinson, and A. L. Archer. 1979. An elephant extermination. Environ. Conserv. 6: 305-310.

Haigh, J. C., L. J. Lee, and R. E. Schweinsburg. 1983. Immobilization of polar bears with carfentanil. J. Wildl. Dis. 19: 140-144.

Haigh, J. C., I. Stirling, and E. Broughton. 1984. Clinical experiences with Telazol for polar bear (*Ursus maritimus*) immobilization. Proc. Am. Assoc. Zoo Vet. Pp. 130-131.

Haigh, J. C., I. Stirling, and E. Broughton. 1985. Immobilization of polar bears (*Ursus maritimus*) with a mixture of tiletamine hydrochloride and zolazepam hydrochloride. J. Wildl. Dis. 21: 43-47.

Haigh, J. C., A. S. Dradjat, A. W. English. 1993. Comparison of two extenders for the cryopreservation of chital (*Axis axis*) semen. J. Zoo Wildl. Med. 24: 454-458.

Hale, M. B., S. J. Griesemer, and T. K. Fuller. 1994. Immobilization of porcupines with tiletamine hydrochloride and zolazepam hydrochloride (Telazol®). J. Wildl. Dis. 30: 429-431.

Hall, L. W., and K. W. Clarke. 1991. Anaesthesia of birds, laoboratory animals and wild animals. *In* L. W. Hall and K. W. Clarke (eds). Veterinary Anaesthesia. London, Bailliere Tindall Ltd. Pp. 339-351.

Hall, T. C., E. B. Taft, W. H. Baker, and J. C. Aub. 1953. A preliminary report on the use of Flaxedil to produce paralysis in the white-tailed deer. J. Wildl. Manage. 17: 516-520.

Hallett, D. L., J. D. Rhoades, and R. R. Paddleford. 1979. Immobilization of coyotes with ketamine and propiomazine. J. Am. Vet. Med. Assoc. 175: 1007-1008.

Halloran, D. W., and A. M. Pearson. 1972. Blood chemistry of the brown bear (*Ursus arctos*) from southwestern Yukon Territory, Canada. Can. J. Zool. 50: 827-833.

Hamilton, R. (No date). Capture of deer in Indiana with nicotine salicylate. Research Report of the Indiana Department of Conservation.

Hammond, O., and R. Elsner. 1977. Anesthesia in phocid seals. J. Zoo An. Med. 8: 7-13.

Hanks, J. 1967a. The use of M.99 for the immobilisation of Defassa waterbuck (*Kobus defassa penricei*). E. Afr. Wildl. J. 5: 96-105.

Hanks, J. 1967b. Crossbow darting. Animals – The International Wildlife Magazine. No. 248.

Hanks, J. 1967c. The use of the new "hypodart" for animal immobilization. Puku 5: 228-231.

Hanks, J. 1967d. The capture of young elephants in the Zambesi Valley. Puku 5: 87-90.

Hanks, J., and R. J. Dowsett. 1969. The use of etorphine (M.99) for the immobilisation and translocation of the Puku (*Kobus vardonie*). Puku 5: 123-130.

Harms, C. A., and R. S. Bakal. 1994. Techniques in fish anesthesia. Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. Pp. 202-209.

Harper, J. A. 1964. Succinylcholine chloride for immobilization of Roosevelt Elk in southern Oregon. Oregon State Game Comm. 17 pp.

Harper, J. A. 1965. Immobilization of Roosevelt elk by succinylcholine chloride. J. Wildl. Manage. 29: 339-345.

Harper, R. C. 1984. Anaesthetising reptiles. Vet. Rec. 115: 475-476.

Harrington, R. 1974. Immobilon-Rompun in deer. Vet. Rec. 94: 362.

Harthoorn, A. M. 1960. Methods of control of wild animals with the use of drugs with special reference to therapeutic and veterinary aspects. Int. Zoo Yb. 2: 302-307.

Harthoorn, A. M. 1962a. The capture and relocation of the white (square- lipped) rhinoceros (*Cerathoteium simum simum*) using drug immobilizing techniques, at the Umfolozi Game Reserve, Zululan, Natal. Lammergeyer 2: 1-9.

Harthoorn, A. M. 1962b. Capture of the white (square-lipped) rhinoceros, *Ceratotherium simum simum* (Burchell) with the use of drug immobilisation techniques. Can. J. Comp. Med. 26: 203-208.

Harthoorn, A. M. 1962c. On the use of phencyclidine for narcosis in larger animals. Vet. Rec. 74: 410-411.

Harthoorn, A. M. 1962d. Producing "twilight sleep" in large wild animals. J. Am. Vet. Med. Assoc. 141: 1473.

Harthoorn, A. M. 1962e. Translocation as a means of preserving wild animals. Oryx 6: 215-227.

Harthoorn, A. M. 1963a. Modern trends in animal health and husbandry: ataractic, hypnotic and narcotic mixtures for the capture and handling of large wild animals. Brit. Vet. J. 119: 47-63.

Harthoorn, A. M. 1963b. Neuroleptic narcosis: approach to anesthesia in large animals. Nature. 198: 1116.

Harthoorn, A. M. 1963c. The value of neuroleptic narcosis in restraint, compared with that of anesthesia, sedation or paralysis. Proc. Symposium of African Mammals Zool. Soc. South Africa, Capetown.

Harthoorn, A. M. 1963d. Techniques of handling large animals such as elephant, rhinoceros, and hippopotamus etc. by use of drugs. World Vet. Cong. 1: 183-187.

Harthoorn, A. M. 1965a. Application of pharmacological and physiological principles in restraint of wild animals. Wildl. Mon. 14: 1-78.

Harthoorn, A. M. 1965b. The use of a new oripavine derivative for restraint of domestic hoofed animals. J. So. Afr. Vet. Assoc. 36: 45-50.

Harthoorn, A. M. 1965c. The use of a new oripavine derivative with potent morphine-like activity for the restraint of hoofed wild animals. Res. Vet. Science. 6: 290-299.

Harthoorn, A. M. 1966a. Large animals restraint - a prerequisite for conservation and research. African. 2: 19-21.

Harthoorn, A. M. 1966b. The use of drugs in conservation. Oryx 8: 223-227.

Harthoorn, A. M. 1966c. Restraint of undomesticated animals. J. Am. Vet. Med. Assoc. 149: 875-880.

Harthoorn, A. M. 1967a. Comparative pharmacological reactions of certain wild and domestic mammals to thebaine derivatives in the M-series of compounds. Fed. Proc. 26: 1251-1261.

Harthoorn, A. M. 1967b. Problems and hazards of chemical restraint in wild animals. Int. Zoo Yb. 8: 215-220.

Harthoorn, A. M. 1970. The flying syringe. Geoffrey Bles, London, U. K.

Harthoorn, A. M. 1971a. Advances in anesthesiology in zoo and wild animals: a review of recent advances. XIX Congres mondial Medec. Vet. Mexico. 2: 509.

Harthoorn, A. M. 1971b. The capture and restraint of wild animals. *In* Soma, L. R. (ed.). Textbook of Veterinary Anesthesia. Williams and Wilkins, Baltimore. Pp. 404-437.

Harthoorn, A. M. 1972a. Classification and properties of drugs in common use. Communication for the Specialised University Course on Wildlife Capture Techniques and General Husbandry. Onderstport, South Africa. 45 pp.

Harthoorn, A. M. 1972b. Drug immobilisation of other large wild herbivores (i.e. buffalo, hippo, rhino, elephant, zebra, etc.). Communication for the Specialised University Course on Wildlife Capture Techniques and General Husbandry. Onderstport, South Africa. 17 pp.

Harthoorn, A. M. 1972c. Restraint and neuroleptanalgesia in ungulates. Vet. Rec. 91: 63-66.

Harthoorn, A. M. 1973a. Review of wildlife capture drugs in common use. *In* E. Young (ed.). The Capture and Care of Wild Animals. Human and Rouseau, Cape Town, South Africa. Pp. 14-34.

Harthoorn, A. M. 1973b. The drug immobilization of large wild herbivores other than antelopes. *In* E. Young (ed.). The Capture and Care of Wild Animals. Human and Rouseau, Cape Town, South Africa. Pp. 51-61.

Harthoorn, A. M. 1974. The effects of immobilizing drugs on different species of game animals. Fauna Flora. 25: 12-13.

Harthoorn, A. M. 1976a. The Chemical Capture of Animals. London: Bailliere Tindall. 416 pp.

Harthoorn, A. M. 1976b. Use of Immobilon. Vet. Rec. 99: 240.

Harthoorn, A. M. 1977. Problems relating to capture. Animal Regulation Studies. 1: 23-46.

Harthoorn, A. M. 1980. Exercise as a necessary preliminary to disturbance, restraint or handling of captive wild animals. Communication-Pretoria. 67

Harthoorn, A. M. 1982a. Mechanical capture as a preliminary to chemical immo-

bilization and the use of taming and training to prevent post capture stress. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 150-164.

Harthoorn, A. M. 1982b. Physical aspects of both mechanical and chemical capture. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Human Society, Inc. Milwaukee, Wisconsin. Pp. 63-71.

Harthoorn, A. M., and J. A. Lock. 1960. The rescue of rhinoceros from Kariba Dam. Oryx 5: 352-355.

Harthoorn, A. M., and J. A. Lock. 1961. Advances in the use of muscle relaxing drugs for immobilization and handling of larger land animals. J. Sm. An. Prac. 2: 163-169.

Harthoorn, A. M., and L. P. Luck. 1962. The handling and marking of the wild East African elephant (*Loxondonta africana*) with the use of drug immobilizing technique - second preliminary report. Brit. Vet. J. 118: 526-530.

Harthoorn, A. M., and H. Campbell. 1963. The capture and anesthesia of the African lion in his natural environment. Vet. Rec. 75: 275-276.

Harthoorn, A. M., and I. C. Player. 1963. The narcosis of the white rhinoceros. A series of eighteen case histories. 5th Int. Symp. Dis. Zoo and Wild An., Amsterdam, Tidjdschr. Diergin. 89: 225.

Harthoorn, A. M., and J. Bligh. 1965. The use of a new oripavine derivative with potent morphine-like activity for the restraint of hoofed wild animals. Res. Vet. Sci. 6: 290-299.

Harthoorn, A. M., and I. C. Player. 1967. The pharmacology and chemistry of the M-series of compounds. 9th Int. Symp. Dis. Zoo and Wild An., Prague. 1967: 135-139.

Harthoorn, A. M., and E. Young. 1974. A relationship between acid-base balance and capture myopathy in zebra (*Equus burchelli*) and an apparent therapy. Vet. Rec. 95: 337-342.

Harthoorn, A. M., and K. Van der Walt. 1974. Physiological aspects of forced exercise in wild ungulates with special reference to (so-called) over-straining disease. I. Acid-base balance and pO_2 levels in Blesbok (*Damaliscus dorcas phillipsi*). J. So. Afr. Wildl. Manage. Assoc. 4: 25-28.

Harthoorn, A. M., J. A. Lock, and L. P. Luck. 1961a. Immobilization of wild elephants in Africa. Br. Vet. J. 117: 87.

Harthoorn, A. M., J. A. Lock, and L. P. Luck. 1961b. Handling and marking of wild African elephants (*Loxodonta africana*) with the use of the drug immobilizing technique - a preliminary report. Br. Vet. J. 117: 87-91.

Harthoorn, A. M., S. Harthoorn, and P. D. Sayer. 1971. Two field operations on the African lion (*Felis leo*). Vet. Rec. 89: 159-164.

Hartsfield, S. M. 1982. A review of avian anesthesia. Southwest. Vet. 35: 117-126.

Harvey, B., C. Denny, S. Kaiser, and J. Young. 1988. Remote intramuscular injection of immobilising drugs into fish using a laser-aimed underwater dart gun. Vet. Rec. 122: 174-177.

Hash, H. S., and M. G. Hornocker. 1980. Immobilizing wolverines with ketamine hydrochloride. J. Wildl. Manage. 44: 713-715.

Hastings, B. E., S. G. Stadler, and R. A. Kock. 1989. Reversible immobilization of Chinese water deer (*Hydropotes inermis*) with ketamine and xylazine. J. Zoo Wildl. Med. 20: 427-433.

Hatlapa, H. H. M., and H. Wiesner. 1982. Die Praxis der Wildtierimmobilisation. Verlag Paul Parey, Hamburg und Berlin. 1982: 1-96.

Hattingh, J., P. G. Wright, V. de Vos, L. Levine, M. Ganhao, S. McNairn, A. Russell, C. Knox, S. T. Cornelius, and J. Bar-Noy. 1984. Effects of etorphine and succinyldicholine on blood composition in elephant and buffalo. So. Afr. J. Zool. 19: 286-290.

Hattingh, J. 1985. Remote controlled blood sampling. So. Afr. J. Sci. 81: 644.

Hattingh, J., M. F. Ganhao, F. J. N. Kruger, V. De Vos, and G. W. Kay. 1985. Remote controlled sampling of cattle and buffalo blood. Comp. Biochem. Physiol. 89A: 231-235.

Hattingh, J., N. I. Pitts, V. de Vos, D. G. Moyes, and M. F. Ganhao. 1991. The response of animals to suxamethonium (succinyldicholine) and succinylmonocholine. J. So. Afr. Vet. Assoc. 62: 126-129.

Hattingh, J., C. M. Knox, and J. P. Raath. 1994a. Arterial blood pressure of the African elephant (*Loxodonta africana*) under etorphine anaesthesia and after remobilisation with diprenorphine. Vet. Rec. 135: 458-459.

Hattingh, J., C. M. Knox, J. P. Raath, and D. F. Keet. 1994b. Arterial blood pressure in anaesthetized African elephants. So. Afr. J. Wildl. Res. 24: 15-17.

Hattingh, J., C. M. Knox, and J. P. Raath. 1994c. Arterial blood pressure and blood gas composition of white rhinoceroses under etorphine anaesthesia. So. Afr. J. Wildl. Res. 24: 12-14.

Hattori, Z., N. Kitano, T. Okonogi, Y. Sawai, Y. Kawamura, and S. Yamasato. 1975. [Anesthetic effect of ketamine hydrochloride for snakes]. Snake. 7: 33-37.

Haugen, A. O., M. J. Swenson, M. J. Shult, and S. J. Petersburg. 1976. Immobilization of adult bull bison with etorphine. Proc. Iowa Acdy. Sci. 83: 67-70.

Haupert, J., and M. Lindeen. 1974. The use of ketamine hydrochloride in wild birds, mammals, and reptiles. Iowa St. U. Vet. 36: 21-22.

Hawkey, C. M., T. Frankel, D. Jones, D. Ashton, G. Nevill, M. Hart, C. Alderson, and P. Bircher. 1980. Preliminary report of a study of changes in red blood cells of zoo animals during sedation. *In* Montali, R. J., and G. Migaki (eds.). The Comparative Pathology of Zoo Animals. Smithsonian Institution Press, Washington, D. C. Pp. 625-632.

Hawkey, C. M. 1985. Changes in blood count during sedation and anaesthesia. Brit. Vet. Zool. Soc. Newsletter. 19: 27-31.

Hawkins, R. E., D. C. Autry, and W. D. Klimstra. 1967. Comparison of methods used to capture white-tailed deer. J. Wildl. Manage. 31: 460-464.

Hawkins, R. E., L. D. Martoglio, and G. F. Montgomery. 1968. Cannon-netting deer. J. Wildl. Manage. 32: 191-195.

Hawkins, R. E., W. D. Klimstra, L. W. Lamely, and D. C Autry. 1979. A new

remote capture method for free-ranging deer. J. Mammal. 51: 392-394.

Hayes, F. A., J. H. Jenkins, S. D. Feurt, and J. A. Crockford. 1957. Observations on the use of nicotine for immobilizing semiwild goats. J. Am. Vet. Med. Assoc. 130: 479-482.

Hayes, F. A., J. H. Jenkins, S. D. Feurt, and J. A. Crockford. 1959. The propulsive administration of nicotine as a new approach for capturing and restraining cattle. J. Am. Vet. Med. Assoc. 134: 283-286.

Heard, D. J., and D. O. Beusse. 1993. Combination detomidine, ketamine, and isoflurane anesthesia in California sea lions, *Zalophus californianus*. J. Zoo Wildl. Med. 24: 168-170.

Heard, D. J., E. R. Jacobson, and K. A. Brock. 1986. Effects of oxygen supplementation on blood gas values in chemically restrained juvenile African elephants. J. Am. Vet. Med. Assoc. 189: 1071-1074.

Heard, D. J., G. V. Kollias, A. I. Webb, E. R. Jacobson, and K. A. Brock. 1988. Use of halothane to maintain anesthesia induced with etorphine in juvenile African elephants. J. Am. Vet. Med. Assoc. 193: 254-256.

Heard, D. J., J. H. Olsen, and J. Stover. 1992. Cardiopulmonary changes associated with chemical immobilization and recumbency in a white rhinoceros (*Ceratotherium simum*). J. Zoo Wildl. Med. 23: 197-200.

Heard, D. J., C. Beale, and J. Owens. 1996. Ketamine and ketamine:xylazine ED_{50} for short-term immobilization of the island flying fox (*Pteropus hypomelanus*). J. Zoo Wildl. Med. 27: 44-48.

Heath, R. B., D. Calkins, W. Taylor, D. McAllister, and T. Spraker. 1994. Isoflurane field anesthesia in sea lions. Vet. Surg. 23: 80.

Heath, R. B., D. Calkins, D. McAllister, W. Taylor, and T. Spraker. 1996. Telazol and isoflurane field anesthesia in free-ranging Steller's sea lions (*Eumetopias jubatus*). J. Zoo Wildl. Med. 27: 35-43.

Heaton, J. T., and S. E. Brauth. 1992. Effects of yohimbine as a reversing agent for ketamine-xylazine anesthesia in budgerigars. Lab. An. Sci. 42: 54-56.

Hebert, D. M. 1982. Philosophy, stratification and training courses for the use of drugs by various levels of personnel. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Human Society, Inc. Milwaukee, Wisconsin. 137-149.

Hebert, D. M., and I. M. Cowen. 1971. White muscle disease in the mountain goat. J. Wildl. Manage. 35: 752-756.

Hebert, D. M., and R. J. McFetridge. 1976. Chemical immobilization of North American wildlife. Alberta Parks, Recreation and Wildlife, Edmonton, Alberta, Canada 84 pp.

Hebert, D. M., and R. J. McFetridge. 1982. Chemical immobilization of North American wildlife. Alberta Parks, Recreation and Wildlife, Edmonton, Alberta, Canada 250 pp.

Hebert, D. M., D. W. Lay, and W. G. Turnbull. 1980. Immobilization of coastal grizzly bears with etorphine hydrochloride. J. Wildl. Dis. 16: 339-342.

Hebert, D. M., D. W. Janz, K. Brunt, and J. Youds. 1982. Chemical immobilization of North American elk. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.).

Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 380-392.

Heck, H., and F. Dovigh. 1967. The immobilization of various ungulates with Anectine at Catskill Game Farm. D. Zool. Garten 33: 182-185.

Heck, H., and E. Rivenburg. 1972. Dosages of M99 used in hoofed mammals at Catskill Game Farm. D. Zool. Garten 42: 282-287.

Heck, L. 1965. Narcosis of a polar bear using the projectile gun. Int. Zoo Yb. 5: 193-194.

Heck, L. 1966. Immobilisation einer Hartmann-Bergzebrastute mit Hife des Cap Chur Gun in Tierpark Hellabrunn, München. D. Zool. Garten 32: 312-316.

Heidt, G. A. 1978. A portable anesthesia chamber for intractable small mammals. Lab. An. Sci. 28: 212-213.

Held, J. P., and R. R. Paddleford. 1982. Clinical use of succinylcholine and gallamine in the camel (*Camelus bactrianus*) during general anesthesia. J. Zoo An. Med. 13: 84-87.

Hellgren, E. C., and M. R. Vaughn. 1989. Rectal temperatures of immobilized, snare-trapped black bears in Great Dismal Swamp. J. Wildl. Dis. 25: 440-443.

Hellgren, E. C., R. L. Lochmiller, M. S. Amoss, and W. E. Grant. 1985. Endocrine and metabolic responses of the collared peccary (*Tayassu tajacu*) to immobilization with ketamine hydrochloride. J. Wildl. Dis. 21: 417-425.

Henry, V. G., and G. H. Matschke. 1968. Immobilizing trapped European wild hogs with Cap-Chur-Barb. J. Wildl. Manage. 32: 970-972.

Henry, V. G., and G. H. Matschke. 1972. Immobilizing European wild hogs with sernylan. J. Tennessee Acdy Sci. 47: 81-84.

Henwood, R. R. 1989. Black rhinoceros (*Diceros bicornis*) capture, transportation and boma management by Natal Parks Board. Koedoe 32: 43.

Henwood, R. R., and M. E. Keep. 1989. The capture and translocation of hippopotamus by means of chemical immobilization. Lammergeyer 40: 30-38.

Herbst, L. H., C. Packer, and U. S. Seal. 1985. Immobilization of free-ranging African lions (*Panthera leo*) with a combination of xylazine hydrochloride and ketamine hydrochloride. J. Wildl. Dis. 21: 401-404.

Herman, M. F., J. F. Pepper, and L. A. Herman. 1982. Field and laboratory techniques for anesthetizing marten with halothane gas. Wildl. Soc. Bull. 10: 275-277.

Hertzog, R. E. 1975. Xylazine in exotic animal practice. Proc. Am. Assoc. Zoo Vet. Pp. 40-42.

Hess, L., and J. Knakal. 1985. [First experience with the immobilization with carfentanyl at Zoo Prague]. Gazella. 3: 87-91.

Hess, L., I. Dvoracek, J. Knakal, J. Chlupaty, J. Svobodnik, Z. Vranova, and M. Vrana. 1987. Use of opiates in primates with special emphasis on etorphine and carfentanyl. D. Zool. Garten. 57: 49.

Heuschele, W. P. 1959. Experiences with promazine in captive wild animals. Biochem. Rev. 29: 3-4.

Heuschele, W. P. 1960. Immobilization of captive wild animals with succinylcholine chloride using the projectile type syringe. Int. Zoo Yb. 2: 308-309.

Heuschele, W. P. 1961a. Immobilization of captive wild animals. Vet. Med. 56: 348-351.

Heuschele, W. P. 1961b. Chlordiazepoxide for calming zoo animals. J. Am. Vet. Med. Assoc. 139: 996-998.

Heuschele, W. P. 1961c. Librium (chlordiazepoxide) Roche in some wild animals. Int. Zoo Yb. 3: 116.

Higgins, A. J., and R. A. Kock. 1984. A guide to the clinical examination, chemical restraint and medication of the camel. Br. Vet. J. 140: 485-492.

Higgins, W. Y. 1972. Zebra immobilization at Lion Country Safari. Proc. Am. Assoc. Zoo Vet. P. 237.

Hildebrand, S. V., and T. Hill. 1993. Neuromuscular blockade by use of atracurium in anesthetized llamas. Am. J. Vet. Res. 54: 429-433.

Hill, F. W. G., and D. A. Smith. 1990. Clinical chemistry values for free-ranging elephants (*Loxodonta africana*) in Hwange National Park, Zimbabwe. Zimb. Vet. J. 21: 33-42.

Hime, J. M. 1974. The use of ketamine hydrochloride in non-domesticated cats. Vet. Rec. 95: 193-195.

Hime, J. M., and D. M. Jones. 1970. The use of xylazine in captive wild ruminants. 12th Int. Symp. Dis. Zoo and Wild An. Budapest. Pp. 143-146.

Hinsch, H., and C. P. Gandal. 1969. The effects of etorphine (M-99), oxymorphone hydrochloride and meperidine hydrochloride in reptiles. Copeia 1969: 404-405.

Hiramatsu, H. 1993. Using anesthesia. An. Zoos 45: 14-17.

Hirst, S. M. 1966. Immobilization of the transvaal giraffe (*Giraffa camelopardalis geraffa*) using an oripovine derivative. J. So. Afr. Vet. Assoc. 37: 85-89.

Hirst, S. M., W. K. Kettlitz, and G. P. Visagie. 1963. The use of Ro 5-2807 (Roche) as a tranquilliser in wild ungulates. Zool. Afr. 1: 231-238.

Hitchins, P. M., M. E. Keep, and K. Rochat. 1972. The capture of black rhinoceros in Hluhluwe Game Reserve and their translocation to the Kruger National Park. Lammergeyer 17: 9: 18-22.

Hochleithner, M. 1992. Erfahrungen mit der Isofluran (Forane) Narkose bei Vogeln und Reptilien. Erkr. Zootiere. 34: 171-177.

Hochleithner, M. 1993. Isoflurane anaesthesia in birds and reptiles. Wiener Tierarztliche Monatsschrift 80: 100, 102-105.

Hoekstra, T. W. 1968. Cap-Chur syringes modified for easier locating. J. Wildl. Manage. 32: 626-628.

Hofman, D. E., and H. Weaver. 1980. Immobilization of captive mallards and pintails with alpha-chloralose. Wildl. Soc. Bull. 8: 156-158.

Hofmeyr, J. M. 1974. Developments in the capture and airlift of roan antelope *Hippotragus equinus equinus* under narcosis to the Etosha National Park. Madoqua Ser. 1. 8: 37-48.

Hofmeyr, J. M. 1977. The introduction of R 33799 in game immobilization procedures. Etosha Ecological Institute. Pp. 1-9.

Hofmeyr, J. M. 1978. Immobilisation of black rhinos, eland and roan antelope with R 33799. Etosha Ecological Institute.

Hofmeyer, J. M. 1981. The use of haloperidol as a long-acting neuroleptic in game capture operations. J. So. Afr. Vet. Assoc. 52: 273-282.

Hofmeyr, and J. R. de Bruine. 1973. The problems associated with the capture, translocation and keeping of wild ungulates in South West Africa. Lammergeyer 18: 21-29.

Hofmeyr, J. M., H. Ebedes, R. E. M. Fryer, and J. R. de Bruine. 1975. The capture and translocation of the black rhinoceros *Diceros bicornis* Linn. in South West Africa. Madoqua. 9: 35-44.

Hofmeyr, J. M., H. G. Luchtenstein, and P. K. N. Mostert. 1977. Capture, handling and transport of springbok and the application of haloperidol as a long-acting neuroleptic. Madoqua. 10: 123-130.

Hoilien, J., and D. Oates. 1982. Tranquilizer use in wildlife damage control. Proc. Great Plains Wildl. Damage Control Workshop. 5: 71-77.

Holbrook, H. T., and M. R. Vaughan. 1985. Capturing adult and juvenile wild turkeys with adult doses of alpha-chloralose. Wildl. Soc. Bull. 13: 160-163.

Holmes, A. A. 1974. Immobilon in the otter. Vet. Rec. 95: 574.

Holmes, R. G., and S. Ngethe. 1973. Restraint of captive and wild lion (*Panthera leo*), leopard (*Panthera pardus*), and cheetah (*Acinonyx jubatus*). Vet. Rec. 92: 290-291.

Holt, G., J. J. Nygard, and A. Tevik. 1971. Bruk av injeksjonsgevaer til innfanging av ville eller forvillede. [The use of injection guns for catching wild or wild-running animals]. Nor. Vet. Tidsskr. 83: 3-10.

Holt, K., and S. P. Manning. 1978. The Missouri stabbing stick. Vet. Rec. 103: 186.

Holz, P. 1992. Immobilization of marsupials with tiletamine and zolazepam. J. Zoo Wildl. Med. 23: 426-428.

Holz, P., and J. E. F. Barnett. 1996. Long-acting tranquilizers: their use as a management tool in the confinement of free-ranging red-necked wallabies (*Macropus rufogriseus*). J. Zoo Wildl. Med. 27: 54-60.

Holz, P., R. M. Holz, and J. E. F. Barnett. 1994. Effects of atropine on medetomidine/ketamine immobilization in the gray wolf (*Canis lupus*). J. Zoo Wildl. Med. 25: 209-213.

Hönich, M. 1970. Untersuchungen über die Wirkung von Bay Va 1470 beim Wild. 12th Int. Symp. Dis. Zoo and Wild An. Budapest. Pp. 153-154.

Hoover, J. P. 1984. Surgical implantation of radiotelemetry devices in American river otters. J. Am. Vet. Med. Assoc. 185: 1317-1320.

Hoover, J. P. 1985. Electrocardiograms of American river otters (*Lutra canadensis*) during immobilization. J. Wildl. Dis. 21: 331-334.

Hoover, J. P., and E. M. Jones. 1986. Physiologic and electrocardiographic responses of American river otters (*Lutra canadensis*) during chemical immobilization and inhalation anesthesia. J. Wildl. Dis. 22: 557-563.

Hoover, J. P., C. R. Root, and M. A. Zimmer. 1984. Clinical evaluation of American river otters in a reintroduction study. J. Am. Vet. Med. Assoc. 185: 1321-1326.

Hornocker, M. G., and W. V. Wiles. 1972. Immobilizing pumas (*Felis concolor*)with

phencyclidine hydrochloride. Int. Zoo Yb. 12: 220-222.
Hornocker, M. G., J. J. Craighead, and E. W. Pfeiffer. 1965. Immobilizing mountain lions with succinylcholine chloride and pentobarbital sodium. J. Wildl. Manage. 29: 880-883.
Houston, A. H., J. A. Madden, R. J. Woods, and H. M. Miles. 1971. Some physiological effects of handling and tricaine methanesulphonate anesthetization upon brook trout, *Slavelinus fontinalis*. J. Fish. Res. Bd. Canada 28: 625-633.
Houston, D. B. 1969. Immobilization of the Shiras moose. J. Wildl. Manage. 33: 534-537.
Houston, D. B. 1970. Immobilization of moose with M99 etorphine. J. Mammal. 51: 396-399.
Houston, D. C., and J. E. Cooper. 1973. Use of the drug metomidate to facilitate the handling of vultures. Int. Zoo Yb. 13: 269-271.
Howe, D. L. 1966. Investigation of tranquilizing, anesthetizing and immobilizing drugs when used on game animals. Wyoming Job Completion Report FW-3-R-13. WP9-J3W. 15 pp.
Hsu, W. H., and W. P. Shulaw. 1984. Effect of yohimbine on xylazine-induced immobilization in white-tailed deer. J. Am. Vet. Med. Assoc. 185: 1301-1303.
Hubbell, G. L. 1965. Capture and restraint of zoo animals. J. Am. Vet. Med. Assoc. 147: 1044-1048.
Hughes, H. C., W. J. White, and C. M. Lang. 1975. Guidelines for the use of tranquilizers, anesthetics, and analgesics in laboratory animals. Vet. Anesth. 3: 19-23.
Hugie, R. D. 1977. Use of chemical restraints in handling wildlife. Parks 2: 19-22.
Hugie, R. D., J. Landry, and J. Hermes. 1977. The use of ketamine hydrochloride as an anesthetic in black bears (*Ursus americanus*) in Maine. Trans. Northeast Sect. Wildl. Soc. 33: 83-86.
Hugues, F., M. Leclerc-Cassan, and J. P. Marc. 1986. [Anaesthesia of untamed animals. The attempted use of a new anaesthetic: the combination tiletamine-zolazepam (Zoletil N.D.)]. Recl. Med. Vet. Ec. Alfort. 162: 427-431.
Hunt, P. S. 1976. Anaesthesia of the European badger using ketamine hydrochloride. Vet. Rec. 98: 94.
Hunt, T. J. 1964. Anesthesia of the tortoise. *In* Graham-Jones, O. (ed.). Small Animal Anesthesia. Pergamon Press, Macmillan Co., New York.
Hyman, W. B. 1992. Veterinary restraint drugs with special reference to detomidine. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 25-30.
Idowu, A. L., and J. F. Akinrinmade. 1986. Xylazine and ketamine anaesthesia in captive Nile crocodiles (*Crocodylus niloticus*). Trop. Vet. 4: 139-142.
Indrebø, A. 1989. Anestesi av blarev med Ketelar® og Rompun® [Anesthesia of blue foxes using ketamine and xylazine). Nor. Veterinäeridsskr. 101: 767-770.
International Zoo Yearbook. 1960. Doses and effects of succinylcholine chloride delivered with projectile syringe to immobilize several species of wild animals at the San Diego Zoo. Int. Zoo Yb. 2: 319-321.
International Zoo Yearbook. 1961. A table of paralytic drugs used to restrain ani-

mals at the Bloemfontein zoo, South Africa. Int. Zoo Yb. 3: 121.
IWVS. 1992. Wildlife Restraint Series. International Wildlife Veterinary Services, Salinas, California.
Jackson, O. F. 1970. Snake anesthesia. Br. J. Herpetol. 4: 172-175.
Jackson, O. F., and J. E. Cooper. 1981. Anesthesia and surgery. *In* Cooper, J. E., and O. F. Jackson (eds.). Diseases of the Reptilia, Vol. 2. New York, Academic Press. Pp. 535-549.
Jacobsen, N. K. 1983. Effects of age and behavior of black-tailed deer on dosages of xylazine. J. Wildl. Manage. 47: 252-255.
Jacobsen, N. K., S. P. Armstrong, and A. N. Moen. 1976. Seasonal variation in succinylcholine immobilization of captive white-tailed deer. J. Wildl. Manage. 40: 447-453.
Jacobson, E. R. 1983. Hematologic and serum chemical effects of a ketamine/xylazine combination when used for immobilizing springbok. J. Am. Vet. Med. Assoc. 183: 1260-1262.
Jacobson, E. R. 1984. Immobilization, blood sampling, necropsy techniques and diseases of crocodilians: a review. J. Zoo An. Med. 15: 38-45.
Jacobson, E. R., and G. V. Kollias. 1984. Yohimbine antagonism of ketamine/xylazine tranquillization and immobilization in hoofstock. Proc. Am. Assoc. Zoo Vet. P. 57.
Jacobson, E. R., and J. Lukas. 1988. Immobilization of dama gazelle (*Gazella dama*) with carfentanil citrate. Chinkara 1: 12-18.
Jacobson, E. R., J. Allen, H. Martin, and G. V. Kollias. 1985. Effects of yohimbine on combined xylazine-ketamine-induced sedation and immobilization in juvenile African elephants. J. Am. Vet. Med. Assoc. 187: 1195-1198.
Jacobson, E. R., C.-L. Chen, R. Gronwall, and A. Tiller. 1986. Serum concentrations of etorphine in juvenile African elephants. J. Am. Vet. Med. Assoc. 189: 1079-1081.
Jacobson, E. R., D. J. Heard, R. Caligiuri, and G. V. Kollias. 1987. Physiological effects of etorphine and carfentanil in African elephants. Proc. Int. Conf. Zool. Avian Med. 1: 525-527.
Jacobson, E. R., G. V. Kollias, D. J. Heard, and R. Caliguiri. 1988. Immobilization of African elephants with carfentanil and antagonism with nalmefene and diprenorphine. J. Zoo An. Med. 19: 1-7.
Jaczewski, Z. and K. Swierzynski. 1955. Anaesthesia in the European bison (*Bison bonasus* L.) by chloralum hydratum. Zool. Pol. 6: 80-87.
Jainudeen, M. R. 1970. The use of etorphine hydrochloride for restraint of a domesticated elephant. J. Am. Vet. Med. Assoc. 157: 624-626.
Jainudeen, M. R., and M. Khan. 1977. The immobilization and translocation of wild Asian elephant, *Elephas maximus*, in peninsular Malaysia. Kajian Vet. 9: 1-7.
Jainudeen, M. R., T. A. Bongso, and B. M. O. A. Perera. 1971. Immobilisation of aggressive working elephants (*Elaphus maximus*). Vet. Rec. 89: 686-688.
Jalanka, H. H. 1986. The chemical restraint and anesthesia of Finnish wildlife species and some other species kept in Helsinki Zoo. Br. Vet. Zool. Soc. Newsl.

21: 31-37.

Jalanka, H. H. 1987. Clinical-pharmacological properties of a new sedative—medetomidine—and its antagonist, MPV-1248. Proc. Int. Conf. Zool. Avian Med. 1: 530-534.

Jalanka, H. H. 1988. Evaluation of medetomidine- and ketamine-induced immobilization in markhors (*Capra falconeri megaceros*) and its reversal by atipamezole. J. Zoo An. Med. 19: 95-105.

Jalanka, H. H. 1989a. Chemical restraint and reversal in captive markhors (*Capra falconeri megaceros*): a comparison of two methods. J. Zoo An. Med. 20: 413-422.

Jalanka, H. H. 1989b. Evaluation and comparison of two ketamine-based immobilization techniques in snow leopards (*Panthera uncia*). J. Zoo An. Med. 20: 163-169.

Jalanka, H. H. 1989c. Medetomidine- and ketamine-induced immobilization of snow leopards (*Panthera uncia*): doses, evaluation, and reversal by atipamezole. J. Zoo An. Med. 20: 154-162.

Jalanka, H. H. 1989d. Medetomidine- and ketamine-induced immobilization in forest reindeer (*Rangifer tarandus fennicus*) and its reversal by atipamezole. Proc. Am. Assoc. Zoo Vet. Pp. 1-7.

Jalanka, H. H. 1989e. The use of medetomidine, medetomidine-ketamine combinations, and atipamezole at Helsinki Zoo—a review of 240 cases. Acta Vet. Scand. 85: 193-197.

Jalanka, H. H. 1990. Medetomidine- and medetomidine-ketamine-induced immobilization in blue foxes (*Alopex lagopus*) and its reversal by atipamezole. Acta Vet. Scand. 31: 63-71.

Jalanka, H. H. 1992. Physiologic responses to medetomidine, medetomidine-ketamine combinations, and atipamezole in nondomestic animals. *In* Short, C. E. (ed.). Animal Pain. Churchill Livingston, New York. Pp. 220-223.

Jalanka, H. H. 1993. New α_2-adrenoceptor agonists and antagonists. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 477-481.

Jalanka, H. H., and B. O. Roeken. 1990. The use of medetomidine, medetomidine-ketamine combinations, and atipamezole in nondomestic animals: a review. J. Zoo Wildl. Med. 21: 259-282.

Jalanka, H. H. , and E. Teräväinen. 1992. Propofol - a potentially useful intravenous anesthetic agent in non-domestic ruminants and camelids. Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. Pp. 264-270.

Janssen, D. L., and J. E. Oosterhuis. 1984. Guaifenesin for muscle relaxation in immobilized hoofstock. Proc. Am. Assoc. Zoo Vet. P. 59.

Janssen, D. L., J. E. Oosterhuis, J. L. Allen, and T. H. Stanley. 1987. Carfentanil immobilization of non-domestic livestock. Proc. 1st Int. Conf. Zool. Avian Med. Omnipress, Madison, Wisconsin. 1: 582.

Janssen, D. L., J. P. Raath, G. E. Swan, D. Jessup, and T. H. Stanley. 1991. Field studies with the narcotic immobilizing agent A3080. Proc. Am. Assoc. Zoo Vet. Pp. 340-342.

Janssen, D. L., G. E. Swan, J. P. Raath, S. W. McJames, J. L. Allen. V. de Vos, K. E. Williams, J. M. Anderson, and T. H. Stanley. 1993. Immobilization and physiological effects of the narcotic A-3080 in impala (*Aepyceros melampus*). J. Zoo Wildl. Med. 24: 11-18.

Janssen, P. 1969. Immobilization and restraint of large wild mammals with azaperone and fentanyl. Janssen Pharmaceutica, Beerse, Belgium.16 pp.

Janssen, P. A. J. 1981. Potent new analgesics, tailor-made for different purposes. Janssen Res. News 6: 2-15.

Jarofke, C. D. 1980. Cervidae. *In* Klos, H. G., E. M. Lang (eds.). Handbook of Zoo Medicine. Van Nostrand Reinhold Company New York. Pp. 223-247.

Jarofke, D. 1978. Improvements of the distance-injection systems and the successful application of a variable-length blow-gun. Proc. Am. Assoc. Zoo Vet. Pp. 24-25.

Jarofke, D. 1981a. Use of halothane-oxygen anesthesia in elephants (*Elephas maximus*). J. Zoo An. Med. 12: 93-95.

Jarofke, D. 1981b. Etorphine anesthesia in the elephant. J. Zoo An. Med. 11: 90-92

Jarvis, C., and D. Morris (eds.). 1960. Animal Restraint Technique Survey. Int. Zoo Yb. 2: 300-327.

Jasinski, D. R., J. D. Griffith, and C. B. Carr. 1975. Etorphine in man I. Subjective effects and suppression of morphine abstinence. Clin. Pharmacol. Ther. 17: 267-272.

Jenkins, D. H. 1978. The use of etorphine (M99) and diprenorphine (M5050) for anesthesia in a white rhinoceros for the removal of growths on the third eyelid. Auburn Vet. 34: 39-43.

Jenkins, D., and M. L. Gorman. 1981. Anaesthsia of the European otter *Lutra lutra* using ketamine hydrochloride. J. Zool. 194: 265-267.

Jenkins, J. H., S. D. Feurt, F. A. Hayes, and J. A. Crockford. 1955. A preliminary report on the use of drugs for capturing deer. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 9: 41-43.

Jenkins, J. H., F. A. Hayes, S. D. Feurt, and J. A. Crockford. 1961. A new method for the live capture of canines with applications to rabies control. Am. J. Public Health. 51: 902-908.

Jensen, J. M. 1982. Fentanyl citrate immobilization of zoo ungulates. J. Zoo An. Med. 13: 101-103.

Jensen, J. M., N. S. Matthews, and S. M. Hartsfield. 1994. Metabolic scaling of ketamine in ostriches and emus. Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. Pp. 134-137.

Jensen, J., P. Tamas, B. and McNeil. 1983. Antagonism of xylazine/atropine immobilization by yohimbine and 4-aminopyridine. Proc. Am. Assoc. Zoo Vet. Pp. 65-66.

Jepsen, O. R., G. Dirch-Paulson, and G. Jorgensen. 1981. Collection of blood, sedation and anaesthesia in mink. A haematological and clinical-chemical study. Nord. Vet-Med. Suppl. Pp. 1-99.

Jessup, D. A. 1982a. Chemical capture of upland game birds and waterfowl: Oral anesthetics. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical

Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 214-226.

Jessup, D. A. 1982b. Restraint and chemical immobilization of carnivores and furbearers. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc., Milwaukee, Wisconsin. Pp. 227-244.

Jessup, D. A. 1992a. On capturing bighorn sheep. J. Wildl. Dis. 28: 512-513.

Jessup, D. A. 1992b. Veterinary contributions toward improving capture, medical management, and anesthesia of free-ranging wildlife. J. Am. Vet. Med. Assoc. 200: 653-658.

Jessup, D. A. 1993. Remote treatment and monitoring of wildlife. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 499-504.

Jessup, D., B. Hunter, and W. Clark. 1980. Wildlife restraint handbook. California Dept. Fish and Game, Rancho Cordova, Cal. 160 pp.

Jessup, D. A., J. W. Foster, and W. E. Clark. 1982a. An electronic means of immobilizing deer: Taser. California Vet. 36: 31-34.

Jessup, D. A., R. Mohr, and B. Feldman. 1982b. A comparison of four methods for capturing bighorn. Desert Bighorn Council Trans. P. 21-25.

Jessup, D. A., R. Mohr, and B. Feldman. 1982c. Comparing methods of capturing bighorn sheep: a preliminary report. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 422-438.

Jessup, D. A., W. E. Clark, P. A. Gullett, and K. R. Jones. 1983. Immobilization of mule deer with ketamine and xylazine, and reversal of immobilization with yohimbine. J. Am. Vet. Med. Assoc. 183: 1339-1340.

Jessup, D. A., W. E. Clark, and K. R. Jones. 1984a. Immobilization of captive mule deer with carfentanil. J. Zoo An. Med. 15: 8-10.

Jessup, D. A., W. E. Clark, and R. C. Mohr. 1984b. Capture of bighorn sheep: management recommendations. Wildlife Management Branch Administrative Report 84-1, Pp. 1-29.

Jessup, D. A., K. Jones, R. Mohr, and T. Kucera. 1985a. Yohimbine antagonism to xylazine in free-ranging mule deer and desert bighorn sheep. J. Am. Vet. Med. Assoc. 187: 1251-1253.

Jessup, D. A., W. E. Clark, K. R. Jones, R. Clark, and W. R. Lance. 1985b. Immobilization of free-ranging desert bighorn sheep, tule elk, and wild horses, using carfentanil and xylazine: reversal with naloxone, diprenorphine, and yohimbine. J. Am. Vet. Med. Assoc. 187: 1253-1254.

Jessup, D. A., R. K. Clark, R. A. Weaver, and M. D. Kock. 1988. The safety and cost-effectiveness of net-gun capture of desert bighorn sheep (*Ovis canadensis nelsoni*). J. Zoo An. Med. 19: 208-213.

Jessup, D. A., M. D. Kock, and P. Morkel. 1993. Health data gained from black rhino immobilized for relocation. *In* Ryder, O. A. (ed.). Rhinoceros Biology and Conservation. Zoological Society of San Diego, San Diego. Pp. 311-314.

Jewell, P. A., and E. A. Smith. 1965. Immobilization of grey seals. J. Wildl. Man-

age. 29: 316-318.

Jewell, P. A., and V. P. W. Lowe. 1965. A trial with the projectile-syringe rifle to capture wild red deer on Rhum. J. Zool. 146: 2672-277.

Jewell, P. A., P. Keen, and E. H. Tong. 1965. The use of the muscle relaxant suxethonium to immobilize captive animals with the projectile syringe rifle. J. Zool. 146: 263-271.

Johnsingh, A. J. T., J. Joshua, R. Chellam, N. V. K. Ashraf, V. Krishnamurthy, and D. V. S. Khati. 1993. Etorphine and acepromazine combination for immobilising wild Indian elephants, *Elephas maximus*. J. Bombay Nat. Hist. Soc. 90: 45-49.

Johnson, J. H. 1991. Anesthesia, analgesia and euthanasia of reptiles and amphibians. Proc. Am. Assoc. Zoo Vet. Pp. 132-138.

Johnston, N. L. 1974. Techniques for anesthetizing and vaccinating exotic Felidae. Vet. Med. Small An. Clin. 69: 1243-1247.

Jolly, D. W., L. E. Mawdsley-Thomas, and D. Bucke. 1972. Anaesthesia in fish. Vet. Rec. 91: 424-426.

Jones, D. M. 1971a. Sedation of a bull musk ox (*Ovibos moschatus*). D. Zool. Garten 40: 138-142.

Jones, D. M. 1971b. Sedation of a bull musk ox *Ovibos moschatus* using xylazine. Int. Zoo Yb. 11: 242-244.

Jones, D. M. 1972. The use of drugs for immobilization, capture and translocation of non-domestic animals. Vet. Ann. 13: 320-352.

Jones, D. M. 1976a. An assessment of weapons and projectile syringes used for capturing mammals. Vet. Rec. 99: 250-253.

Jones, D. M. 1976b. The husbandry and veterinary care of wild horses in captivity. Equine Vet. J. 8: 140-146.

Jones, D. M. 1977a. Immobilising exotic animals. Vet. Rec. 101: 352-353.

Jones, D. M. 1977b. The sedation and anaesthesia of birds and reptiles. Vet. Rec. 101: 340-342.

Jones, D. M. 1978. A short analysis of 2000 ungulate immobilizations involving 71 species mainly from the collection of the Zoological Society of London. *In* Sonderdruck aus Verhandlungsbericht des XX Internationalen Symposiums über die Erkrankungen der Zootiere Kralove 1978, Berlin, Akafemie-Verlag. Pp. 173-178.

Jones, D. M. 1983. The capture and handling of deer. *In* Rudge, A. J. B. (ed.). The Capture and Handling of Deer. Nature Conservancy Council, Peterborough, England. Pp. 1-136.

Jones, D. M. 1984. Physical and chemical methods of capturing deer. Vet. Rec. 114: 109-112.

Jones, R. D. 1966. A comparison between morphine and M99 for the immobilization of the black rhinoceros. M-series Vet. Appl. Rpt. No. 46, Reckitt and Sons, Hull, England.

Jones, R. D., and H. H. Roth. 1968. Cooperative study of the efficiency of morphine and etorphine (M.99) in the immobilisation of black rhinoceros (*Diceros bicornis* L.). Wildlife National Parks, Rhodesia. 16 pp.

Jones, W. T., and B. B. Bush. 1988. Darting and marking techniques for an arboreal forest monkey, *Cercopithecus ascanius*. Am. J. Primatol. 14: 83-89.

Jonkel, C. J., and R. P. Weckwerth. 1963. Sexual maturity and implantation of blastocysts in the wild pine marten. J. Wildl. Manage. 27: 93-98.

Jonkel, C. J., D. R. Gray, and B. Hubert. 1975. Immobilizing and marking wild muskoxen in arctic Canada. J. Wildl. Manage. 39: 112-117.

Jorgenson, J. T., J. Samson, and M. Festa-Bianchet. 1990. Field immobilization of bighorn sheep with xylazine hydrochloride and antagonism with idazoxan. J. Wildl. Dis. 26: 522-527.

Joseph, B. E., and L. H. Cornell. 1987. The use of meperidine hydrochloride in cetaceans and pinnipeds. Proc. 1st Int. Conf. Zool. Avian Med. 1: 400.

Joseph, B. E., and L. H. Cornell. 1988. The use of meperidine hydrochloride for chemical restraint in certain cetaceans and pinnipeds. J. Wildl. Dis. 24: 691-694.

Joseph, B. E., L. H. Cornell, and T. Williams. 1987. Chemical sedation of sea otters. J. Zoo An. Med. 18: 7-13.

Joshi, B. P. 1991. Wild Animal Medicine. Oxford and IBH Publishing Co., New Delhi, India. 279 pp.

Joyal, R., G. Rivard, and J. Vallee. 1978. L'evaluation de methodes d'immobilisation d'orignaux en liberte pour etudes telemetriques. [Evaluation of methods of moose immobilization for telemetric studies]. Nat. Can. (Que.). 105: 451-456.

Ju Guichun et al. 1992. Mian nai ning (MNN) - a new anesthetic used for black bear and brown bear. Acta Agric. Univ. Jilinensis 14: 64-66.

Kane, K. K. 1979. Medical management of the otter. Proc. Am. Assoc. Zoo Vet. Pp. 100-103.

Kania, B. F. 1985. Neurochemical changes in the brain and spinal cord of sheep: a basis for the immobilizing action of etorphine. J. So. Afr. Vet. Assoc. 56: 89-92.

Kania, B. F., and J. K. Teuchmann. 1975. The use of etorphine hydrochloride (M99) as an immobilizing agent in the European bison (*Bison bonasus* L.). Zool. Pol. 25: 85-98.

Kania, B. F., E. Suminski, and J. Kossakowski. 1985. An effective immobilizing agent for hybrids of European bison and domestic cattle. Acta Theriol. 30: 435-444.

Kania, B. F., J. K. Teuchmann, S. Piwowarczyk, and Z. Krasinski. 1973. Badania nad immobilizujacym dzialaniem chlorowodorkiem cyprenorfiny (M 285). [Pharmacological aspects of immobilizing effects of M 99 in *Bison bonasus* L. and attempts to antagonize these effects with M 285]. Przegl. Zool. 17: 242-247.

Kaplan, H. M. 1969. Anesthesia in amphibians and reptiles. Fed. Proc. 28: 1541-1546.

Kaplan, H. M., and R. Taylor. 1957. Anesthesia in turtles. Herpetologica 13: 43-45.

Kaplan, H. M., and M. Kaplan. 1961. Anesthesia of frogs with ethyl alcohol. Proc.

An. Care Panel 11: 31-35.

Kaplan, H. M., N. R. Brewer, and M. R. Kaplan. 1962. Comparative value of some barbiturates for anesthesia in the frog. Proc. An. Care Panel. 12: 141.

Karesh, W. B., D. L. Janssen, and J. E. Oosterhuis. 1986. A comparison of carfentanil and etorphine/xylazine immobilization of axis deer. J. Zoo An. Med. 17: 58-61.

Karlstrom, E. L., and S. F. Cook. 1955. Notes on snake anesthesia. Copeia 1: 57-58.

Karns, P. D., and V. F. J. Crichton. 1978. Effects of handling and physical restraint on blood parameters of woodland caribou. J. Wildl. Manage. 42: 904-908.

Kaufman, P. L., and R. Hahnenberger. 1975. CI-744 anesthesia for opthamological examination and surgery in monkeys. Invest. Opthalmol. 14: 788-791.

Kattel, B., and A. W. Alldredge. 1991. Capturing and handling of the Himalayan musk deer. Wildl. Soc. Bull. 19: 397-399.

Keep, J. M. 1971. Some observations on the use of drugs for the capture of feral beffalo. Austral. Vet. J. 47: 553-556.

Keep, J. M. 1973. Notes on the field capture of the agile wallaby (*Macropus agilis*). Austral. Vet. J. 49: 385-387.

Keep, J. M. 1978. Marsupials - anaesthesia. Proc. Post-Grad. Committee in Vet. Sci., U. Sydney. 36: 123-124.

Keep, J. M., and A. M. Fox. 1971. The capture, restraint, and translocation of kangaroos in the wild. Austral. Vet. J. 47: 141.

Keep, M. E. 1969. Report on the immobilization of white rhinoceros using fentanyl (R4263). Janssen Pharmaceutica, Beerse.

Keep, M. E. 1971. Etorphine hydrochloride antagonists used in the capture of the white rhinoceros *Ceratotherium simum simum*. Lammergeyer. 3: 60-68.

Keep, M. E. 1972a. The use of "Rompun" (Va 1470) Bayer on the white rhinoceros. Lammergeyer. 17: 31-35.

Keep, M. E. 1972b. The use of "Rompun" (Va 1470) Bayer on the white rhinoceros. J. Zoo An. Med. 4: 21-24.

Keep, M. E. 1972c. Capturing lions on the loose. Vet. Clin. 9: 2-3.

Keep, M. E. 1973a. The immobilization and translocation of black wildebeest. Lammergeyer 18: 39-43.

Keep, M. E. 1973b. The use of etorphine hydrochloride (M99) (Reckitt), fentanyl (Janssen) and hyoscine hydrobromide combination for field capture of white rhinoceros. Lammergeyer 19: 28-30.

Keep, M. E. 1973c. The problems associated with the capture and translocation of the black rhinoceros in Zululand, Republic of South Africa. Lammergeyer 18: 15-20.

Keep, M. E. 1979. The sedation and immobilisation of deer. Proc. Refresher Course for Veterinarians, The Australian Museum, Sydney. 49: 21-28.

Keep, M. E. 1992. The immobilization and tranquillization of rhino. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 44-46.

Keep, M. E., and P. J. Keep. 1967. Immobilization of waterbuck. Vet. Rec. 81:

552.

Keep, M. E., and P. J. Keep. 1968. The immobilization of eland using new drug combinations. Lammergeyer 9: 18-23.

Keep, M. E., J. L. Tinley, K. Rochat, and J. V. Clark. 1969. The immobilization and translocation of black rhinoceros *Diceros bicornis* using etorphine hydrochloride (M99). Lammergeyer 10: 4-11.

Keffen, R. H. 1993. The ostrich *Struthio camelus*: capture, care, accommodation, and transportation. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 634-653.

Keller, G. L., D. H. Bauman, and L. Abbott. 1988. Yohimbine antagonism of ketamine and xylazine anesthesia in rabbits. Lab An. Pp. 28-30.

Keyes, M. 1965. Immobilizing, tranquilizing and anesthetizing drugs used for fur seals, *Callorhinus ursinus*. Conf. Biol. Sonar Diving Mammals. Pp. 74-79.

Khamis, Y., K. Fouad, and A. Sayed. 1973. Vergleichende Untersuchungen von Tranquilizern/Sedativa beim Dromedar. Vet. Med. Nachr. 4: 335-344.

Kilde, A. M., and L. V. Klein. 1973. Restraint of two fallow deer with xylazine. J. Zoo An. Med. 4: 21.

King, J. M. 1969. The capture and translocation of the black rhinoceros. E. Afr. Wildl. J. 7: 115-130.

King, J. M., and B. M. Carter. 1965. The use of oripavine derivative M.99, for the immobilisation of the black rhinoceros (*Diceros bicornis*) and its antagonism with the related compound M.285, or nalorphine.E. Afr. Wildl. J. 3: 19-26.

King, J. M., and H. Klingel. 1965. The use of the oripavine derivative M99 for the restraint of equine animals and its antagonism with the related compound M285. Res. Vet. Sci. 6: 447-455.

King, J. M., B. C. Bertram, and P. H. Hamilton. 1977. Tiletamine and zolazepam for immobilization of wild lions and leopards. J. Am. Vet. Med. Assoc. 171: 894-898.

Kisloff, B. 1975. Ketamine-paraldehyde anesthesia for rabbits. Am. J. Vet. Res. 36: 1033-1034.

Kistchinski, A. A., and S. M. Uspenski. 1970. Immobilization and tagging of polar bears in maternity dens. *In* Herrero, S. (ed.). Bears - Their Biology and Management. IUCN publ. 23: 172-180.

Kitchen, H. 1966. Handling and restraint in deer and other wild animals. Lab. An. Digest 4: 3-7.

Kitchen, H. 1976. The use of succinylcholine in deer. Proc. Am. Assoc. Zoo Vet. Pp. 185-194.

Kittle, E. L. 1971. Ketamine HCL as an anesthetic for birds. Mod. Vet. Pract. 52: 40-41.

Kittle, E. L. 1972. Ketamine hydrochloride as an anesthetic for birds. Raptor Res. 6: 49-50.

Kiyota, M., T. R. Loughlin, N. Baba, M. Nakajima, and K. Kohyama. 1992. Use of a tiletamine hydrochloride zolazepam hydrochloride mixture as an immobilizing agent for northern fur seals *Callorhinus ursinus*. Honyurui Kagaku 32:

1-7 (Japanese).

Klein, L. 1980. Clinical pharmacology of agents used in the restraint of felidae and hoofed stock. Proc. Am. Assoc. Zoo Vet. Pp. 7-12.

Klein, L. V., and A. M. Klide. 1989. Central α_2-adrenergic and benzodiazepine agonists and their antagonists. J. Zoo Wildl. Med. 20: 138-153.

Klein, L., and J. Stover. 1993. Medetomidine-ketamine-isoflurane anesthesia in captive cheetah (*Acinonyx jubatus*) and antagonism with atipamezole. Proc. Am. Assoc. Zoo Vet. Pp. 144-145.

Klein, L., and S. B. Citino. 1995. Comparison of detomidine/carfentanil/ketamine and medetomidine/ketamine anesthesia in Grevy's zebra. Proc. Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 290-293.

Klide, A. M., and L. V. Klein. 1971. Chemical restraint of three reptilean species. J. Zoo An. Med. 4: 8-11.

Klide, A. M., and L. V. Klein. 1971. Restraint of two fallow deer with xylazine. J. Zoo An. Med. 4: 21.

Klingel, H. 1968. Die Immobilisation von Steppenzebras (*Equus quagga bohmi*). D. Zool. Garten. 35: 54-66.

Klöppel, G. 1962. Schwergeburt bei einem See-Elephanten. Nord. Vet. Med. 14 (Suppl. 1): 161-163.

Klöppel, G. 1965. Immobilisation und Narkode bei Zoo und Wildtieren. Berl. Münch. Tierärztl. Wochenschr. 88: 295-298.

Klöppel, G. 1969. Zur Immobilisation von Zoo- und Wildtieren. Die Kleintier-Praxis 14: 203-207.

Klos, H. G., and E. M. Lang (eds.). 1980. Handbook of Zoo Medicine. Van Nostrand Reinhold Company, New York.

Knight, A. P. 1980. Xylazine. J. Am. Vet. Med. Assoc. 176: 454-455.

Knox, C. M., J. Hattingh, and J. P. Raath. 1990. The effect of tranquilizers on the immediate responses to repeated capture and handling of boma-kept impala. Comp. Biochem. Physiol. 95: 247-251.

Knox, C. M., J. Hattingh, and J. P. Raath. 1991. The effect of zeranol on body mass and physiological responses to repeated capture in boma-confined impala. So. Afr. J. Wildl. Res. 21: 38-42.

Kocan, A. A., T. R. Thedford, B. L. Glenn, M. G. Shaw, and R. Wood. 1980. Myopathy associated with immobilization in captive white-tailed deer. J. Am. Vet. Med. Assoc. 177: 879-881.

Kocan, A. A., B. L. Glenn, T. R. Thedford, R. Doyle, K. Waldrup, G. Kubat, and M. G. Shaw. 1981. Effects of chemical immobilization on hematologic and serum chemical values in captive white-tailed deer. J. Am. Vet. Med. Assoc. 179: 1153-1156.

Kocan, A. A., E. F. Blouin, and B. L. Glenn. 1985. Hematologic and serum chemical values for free-ranging bobcats, *Felis rufus* (Schreber), with reference to animals with natural infections of *Cytauxzoon felis* Kier, 1979. J. Wildl. Dis. 21: 190-192.

Koci, P. 1970. Application of injection preparations to animals with Cap-Chur

pistol. Veterinarstvi 20: 568-570. (Czech)

Koci, P. 1971a. Use of Bay Va 1470, 10% Rompun preparation (Bayer, Leverkusen) for immobilization of white bearded gnus (*Connochaetes taurinus albojubatus*). Veterinarstvi 21: 132-134. (Czech)

Koci, P. 1971b. Practical results with the application of BAY Va 1470 10% (Rompun) for the immobilisation of *Hippotragus equinus*. Veterinarstvi 21: 565-567. (Czech)

Koci, P. 1972. Bay Va 1470, 10% (Rompun) its use to immobilize white bearded gnus and roan antelopes. Verhandlungsber. XIV. Internat. Symp. Erkankungen Zootiere, Wroclaw. Pp. 375-384.

Kock, M. D. 1992. Use of hyaluronidase and increased etorphine (M99) doses to improve induction times and reduce capture related stress in the chemical immobilization of free ranging black rhinoceros (*Diceros bicornis*) in Zimbabwe. J. Zoo Wildl. Med. 23: 181-188.

Kock, M. D., and J. Berger. 1987. Chemical immobilization of free-ranging North American bison (*Bison bison*) in Badlands National Park, South Dakota. J. Wildl. Dis. 23: 625-633.

Kock, M. D., and P. Morkel. 1993. Capture and translocation of the free-ranging black rhinoceros: medical and management problems. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 466-475.

Kock, M. D., N. Kock, and A. Arif. 1984. Immobilization techniques and complications associated with bull Indian elephant (*Elephus maximus*) in musth. Proc. Am. Assoc. Zoo Vet. P. 68.

Kock, M. D., D. A. Jessup, R. K. Clark, C. E. Franti, and R. A. Weaver. 1987a. Capture methods in five subspecies of free-ranging bighorn sheep: an evaluation of drop-net, drive-net, chemical immobilization and the net gun. J. Wildl. Dis. 23: 634-640.

Kock, M. D., D. A. Jessup, R. K. Clark, and C. E. Franti. 1987b. Effects of capture on biological parameters in free-ranging bighorn sheep (*Ovis canadensis*): Evaluation of drop-net, drive-net, chemical immobilization and the net-gun. J. Wildl. Dis. 23: 641-651.

Kock, M. D., R. K. Clark, C. E. Franti, D. A. Jessup, and J. D. Wehausen. 1987c. Effects of capture on biological parameters in free-ranging bighorn sheep (*Ovis canadensis*): evaluation of normal, stressed and mortality outcomes and documentation of postcapture survival. J. Wildl. Dis. 23: 652-662.

Kock, M. D., M. la Grange, and R. du Toit. 1990a. Chemical immobilization of free-ranging black rhinoceros (*Diceros bicornis*) using combinations of etorphine (M99), fentanyl and xylazine. J. Zoo Wildl. Med. 21: 155-165.

Kock, M. D., R. du Toit, N. Kock, D. Morton, C. Foggin, M. la Grange, and B. Paul. 1990b. Effects of capture and translocation on biological parameters in free-ranging black rhinoceros (*Diceros bicornis*) in Zimbabwe. J. Zoo Wildl. Med. 21: 414-424.

Kock, M. D., R. du Toit, D. Morton, N. Kock, and B. Paul. 1990c. Baseline biological data collected from chemically immobilized free-ranging black rhi-

noceros (*Diceros bicornis*) in Zimbabwe. J. Zoo Wildl. Med. 21: 283-291.

Kock, M. D., R. B. Martin, and N. Kock. 1993. Chemical immobilization of free-ranging African elephants (*Loxodonta africana*) in Zimbabwe, using etorphine (M99) mixed with hyaluronidase, and evaluation of biological data collected soon after immobilization. J. Zoo Wildl. Med. 24: 1-10.

Kock, M. D., P. Morkel, M. Atkinson, and C. Foggin. 1995. Chemical immobilization of free-ranging white rhinoceros (*Ceratotherium simum simum*) in Hwange and Matobo National Parks, Zimbabwe, using combinations of etorphine (M99), fentanyl, xylazine, and detomidine. J. Zoo Wildl. Med. 26: 207-217.

Kock, R. A. 1987. Remote injection systems: science and art. Vet. Rec. 121: 76-80.

Kock, R. A., and P. C. Pearce. 1985. Anaesthesia in zoo ungulates. J. Assoc. Vet. Anaesth. 13: 59-88.

Kock, R. A., J. P. P. Harwood, P. C. Pearce, and R. N. Cinderey. 1987. Chemical immobilization of Formosan sixa deer (*Cervus nippon*): a physiological study. J. Assoc. Vet. Anaesth. 14: 120-151.

Kock, R. A., P. C. Pearce, and P. Taylor. 1988. The use of detomidine and butorphanol in zoo equids. Proc. Joint Mtg. Am. Assoc. Zoo Vet. Am. Assoc. Wildl. Vet. Pp. 188-191.

Kock, R. A., M. Jago, F. M. D. Gulland, and J. Lewis. 1989. The use of two novel alpha2-adrenoceptor antagonists, idazoxan and its analogue RX821002A in zoo and wild animals. J. Assoc. Vet. Anaesth. 16: 4-10.

Kock, R. A., P. Morkel, and M. D. Kock. 1993. Current immobilization procedures used in elephants. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 436-440.

Kodituwakku, G. E., K. Dissanayake, and D. Seneviratna. 1961. General anaesthesia in an elephant. Ceylon Vet. J. 9: 75-76.

Kok, O. B. 1973. Etorphine (M-99) immobilisation and associated behaviour of the red hartebeest (*Alcelaphus buselaphus caama*). J. So. Afri. Wildl. Manage. Assoc. 3: 9-15.

Kollias, G. V. Jr., and I. McLeish. 1978. Effects of ketamine hydrochloride in red-tailed hawks (*Buteo jamaicensis*) 1 - arterial blood gas and acid-base. Comp. Biochem. Physiol. 60C: 57-59.

Kopf, V. E., D. F. Gibson, A. Oelschlaeger, P. F. Scanlon, R. L. Kirkpatrick, and F. C. Gwazdauskas. 1981a. Effects of xylazine hydrochloride on thyroxine and triiodothyronine in white-tailed deer. Va. J. Sci. 32: 94.

Kopf, V. E., D. F. Gibson, T. J. Dietrick, P. F. Scanlon, and R. L. Kirkpatrick. 1981b. Xylazine hydrochloride for restraint of white-tailed deer. Va. J. Sci. 32: 94.

Koubek, P., and V. Mrlik. 1988. [Immobilization of red deer stags (*Cervus elaphus* L.) using etorphine]. Veterinarni Medicina (Czeck). 123: 375-380.

Krahwinkel, D. J. 1970. The use of tiletamine hydrochloride as an incapacitating agent for a lion. J. Am. Vet. Med. Assoc. 157: 622-623.

Krahwinkel, D. J. 1970. Primate anesthesiology. J. Zoo Anim. Med. 1: 4-12.

Kraner, K. L., A. M. Silverstein, and C. J. Parshall Jr. 1965. Anesthesia in snakes. *In* Sawyer, D. C. (ed.). Symposium on Experimental Animal Anesthesiology. Brooks Air Force Base, Texas. Pp. 374-378.

Krapu, G. L. 1976. Experimental responses of mallards and Canada geese to tribromoethanol. J. Wildl. Manage. 40: 180-183.

Krasinski, Z. A., K. Cabon-Raczynska, and M. Krasinska. 1982. Immobilizing and marking of the European bison. Acta Theriol. 27: 181-190.

Krausman, P. R., J. J. Hervert, L. L. Ordway, K. Rautenstrauch, and T. Remington. 1984. Immobilization of desert mule deer with etorphine plus azaperone. *In* Krausman, P. R., and N. S. Smith (eds.). Deer in the Southwest: A Workshop. New Mexico State University, Las Cruces. Pp. 103-105.

Krausman, P. R., K. R. Rautenstrauch, J. J. Hervert, R. Remington, and L. L. Ordway. 1986. Immobilization of desert mule deer with etorphine plus azaperone. Southwest. Nat. 31: 411-414.

Krechetov, Y. N. 1980. [Catching of corvid birds with the help of narcotics]. Ornitologiya. 15: 211-212.

Kreeger, T. J. 1992. A review of chemical immobilization of wild canids. Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. Pp. 271-283.

Kreeger, T. J., and U. S. Seal. 1986a. Failure of yohimbine hydrochloride to antagonize ketamine hydrochloride immobilization in gray wolves. J. Wildl. Dis. 22: 600-603.

Kreeger, T. J., and U. S. Seal. 1986b. Immobilization of coyotes with xylazine hydrochloride-ketamine hydrochloride and antagonism by yohimbine hydrochloride. J. Wildl. Dis. 22: 604-606.

Kreeger, T. J., and U. S. Seal. 1990. Immobilization of captive gray wolves (*Canis lupus*) with sufentanil citrate. J. Wildl. Dis. 26: 561-563.

Kreeger, T. J., G. D. Del Giudice, U. S. Seal, and P. D. Karns. 1986a. Immobilization of white-tailed deer with xylazine hydrochloride and ketamine hydrochloride and antagonism by tolazoline hydrochloride. J. Wildl. Dis. 22: 407-412.

Kreeger, T. J., G. D. Del Giudice, U. S. Seal, and P. D. Karns. 1986b. Methods of urine collection for male white-tailed deer. J. Wildl. Dis. 22: 442-445.

Kreeger, T. J., U. S. Seal, and A. M. Faggella. 1986c. Xylazine hydrochloride-ketamine hydrochloride immobilization of wolves and its antagonism by tolazoline hydrochloride. J. Wildl. Dis. 22: 397-402.

Kreeger, T. J., A. M. Faggella, U. S. Seal, L. D. Mech, M. Callahan, and B. Hall. 1987a. Cardiovascular and behavioral responses of gray wolves to ketamine-xylazine immobilization and antagonism by yohimbine. J. Wildl. Dis. 23: 463-470.

Kreeger, T. J., E. D. Plotka, and U. S. Seal. 1987b. Immobilization of white-tailed deer by etorphine and xylazine and its antagonism by nalmefene and yohimbine. J. Wildl. Dis. 23: 619-624.

Kreeger, T. J., U. S. Seal, M. Callahan, and M. Beckel. 1988. Use of xylazine sedation with yohimbine antagonism in captive gray wolves. J. Wildl. Dis. 24: 688-690.

Kreeger, T. J., R. E. Mandsager, U. S. Seal, M. Callahan, M. Beckel. 1989a. Physiological response of gray wolves to butorphanol-xylazine immobilization and antagonism by naloxone and yohimbine. J. Wildl. Dis. 25: 89-94.

Kreeger, T. J., D. Monson, V. B. Kuechle, U. S. Seal, and J. R. Tester. 1989b. Monitoring heart rate and body temperature via radio telemetry in red foxes (*Vulpes vulpes*). Can. J. Zool. 67: 2455-2458.

Kreeger, T. J., U. S. Seal, and J. R. Tester. 1990a. Chemical immobilization of red foxes (*Vulpes vulpes*). J. Wildl. Dis. 26: 95-98.

Kreeger, T. J., P. J. White, U. S. Seal, and J. R. Tester. 1990b. Pathological responses of red foxes to foothold traps. J. Wildl. Manage. 54: 147-160.

Kreeger, T. J., U. S. Seal, M. Callahan, and M. Beckel. 1990c. Physiological and behavioral responses of gray wolves to immobilization with tiletamine and zolazepam (Telazol). J. Wildl. Dis. 26: 90-94.

Kreeger, T. J., U. S. Seal, J. R. Tester, M. Callahan, and M. Beckel. 1990d. Physiological responses of red foxes (*Vulpes vulpes*) to surgery. J. Wildl. Dis. 26: 162-174.

Kreeger, T. J., V. B. Kuechle, L. D. Mech, J. R. Tester, and U. S. Seal. 1990e. Physiological monitoring of gray wolves (*Canis lupus*) by radiotelemetry. J. Mammal. 71: 258-261.

Kreeger, T. J., L. A. Degernes, J. S. Kreeger, and P. T. Redig. 1993. Immobilization of raptors with tiletamine and zolazepam (Telazol®). *In* Redig, P. T., J. E. Cooper, J. D. Remple, and D. Bruce Hunter (eds.). Raptor Biomedicine. University of Minnesota Press, Minneapolis. Pp. 141-144.

Kreeger, T. J., D. L. Hunter, and M. R. Johnson. 1995. Immobilization protocol for free-ranging gray wolves (*Canis lupus*) translocated to Yellowstone National Park and central Idaho. Proc. Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 529-530.

Kreeger, T. J., M. Callahan, and M. Beckel. 1996. Use of medetomidine for the chemical restraint of captive gray wolves (*Canis lupus*). J. Zoo Wildl. Med. 27: 99-104.

Kriek, J. C. 1992. Post-darting tranquillization of game. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 52-53.

Kroll, W. R. 1962. Experience with Sernylan in zoo animals. Int. Zoo Yb. 4: 131-141.

Kuehn, G. 1974. Anesthesia in turtles. J. Zoo An. Med. 5: 35.

Kuiken, T. 1988. Anaesthesia in the European otter (*Lutra lutra*). Vet. Rec. 123: 59.

Kuntze, A. 1967. Neuroleptanalgesia in bears. Vet. Rec. 80: 278-280.

Kuntze, A. 1967. Klinische Beiträge zur Anästhesie und Medikamentellen Immobilisation der Zootiere (Ursiden, Feliden, Ruminantier). Zentralblatt für Veterinärmedizin, Beiheft 6. Pp. 1-144.

Kuntze, A. 1976. Vergleichende Betrachtungen über Phenzyklidin-Propionylpromazin und Ketaminhydrochlorid zur Narkose oder Immobilisation von Raubtieren (Löwe, Tiger, Leopard, Puma, Eisbär). 18th Int. Symp. Dis.

Zoo and Wild An. Innsbrück. Pp. 295-301.
Kuntze, A. 1977. Kritische Analyse der Erfahrungen mit Ketamin-Xylazin bei der Immobilisation oder Narkose von Grosskatzen. 19th Int. Symp. Dis. Zoo and Wild An. Pp. 399-405.
Küpper, W., N. Drager, D. Mehlitz, and U. Zillmann. 1981. On the immobilization of hartebeest and kob in Upper Volta. Tropenmed. Parasitol. 32: 58-60.
Küpper, W. 1981. Immobilisierung von freilebenden Kuhantilopen und Schwarzfussmoorantilopen. Der Praktische Tierarzt. 3: 240-244.
Küpper, W., M. Wolters, and J. Gilbert. 1982. Immobilisierung von freilebenden Schwarzfussmoorantilopen. Der Praktische Tierarzt. 63: 994-996.
Kuruwita, V. Y. 1990. Capture and translocation. *In* Proceedings of the Seminar on Conservation Plan for Elephants of Sri Lanka. Department of Wildlife Conservation, Ministry of Lands and Irrigation and Mahaweli Development of Sri Lanka. Pp. 63-69.
Kuttner, C., and H. Wiesner. 1987. Changes in blood values in Przewalski horses (*Equus przewalski przewalski*) and zebras (*Equus zebra hartmannae*) during chemical immobilization. J. Zoo An. Med. 18: 144-147.
Lacki, M. J., P. M. Smith, W. T. Peneston, and F. D. Vogt. 1989. Use of methoxyflurane to surgically implant transmitters in muskrats. J. Wildl. Manage. 53: 331-333.
Laisher. 1972. Anesthesia of reindeer. Veterinariya. 5: 76-78.
Lammintausta, R., O. Vaino, R. Virtanen, and T. Vähä-Vahe (eds.). 1989. Medetomidine, a novel alpha$_2$-agonist for veterinary sedative and analgesic use. Acta Vet. Scand. Suppl. 85. 202 pp.
Lance, W. R. 1991. New pharmaceutical tools for the 1990's. Proc. Am. Assoc. Zoo Vet. Pp. 354-359.
Lancia, R. A., R. P. Brooks, and M. W. Flemming. 1978. Ketamine hydrochloride as an immobilant and anesthetic for beaver. J. Wildl. Manage. 42: 946-948.
Landowska-Plazewska, E. 1970. Erfahrungen mit der Anwendung des Präparates Bay-Va-1470 bei Wildtieren im Zoo Warszawa. 12th Int. Symp. Dis. Zoo and Wild An. Budapest. Pp. 147-151.
Lange, R. E. 1982. Chemical immobilization of North American mule deer. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 363-369.
Langman, V. A. 1973. The immobilization and capture of giraffe. So. Afr. J. Sci. 69: 200-203.
Langrehr, D., and R. Muller. 1967. Significence of CI-581 (ketamine) for anesthesiology in veterinary medicine with special attention to zoo animals. 9th Int. Symp. Dis. Zoo and Wild An., Prague.
Lanphear, P. R. 1963. Tranquilization and immobilization of wild animals. J. Am. Vet. Med. Assoc. 142: 1126-1129.
Larsen, L. H. 1963. Restraint and anesthesia of wild animals in captivity. Austral. Vet. J. 39: 73-80.
Larsen, T. 1966. The trapping and study of polar bears, Spitsbergen 1966. Polar

Record. 13: 587-593.

Larsen, T. 1971. Capture, handling, and marking polar bears in Svalbard, Norway. J. Wildl. Manage. 35: 27-36.

Lateur, N., and P. Stolk. 1986. Repeated general anaesthesia in a male Indian elephant. Proc. Am. Assoc. Zoo Vet. Pp. 128-131.

Lawrence, K., and O. F. Jackson. 1983. Alphaxalone/alphadolone anaesthesia in reptiles. Vet. Rec. 112: 26-28.

Lawson, D., M. Hampton, and C. Morewood. 1987. A custom-built capture rifle for immobilizing small antelopes. Lammergeyer. 38: 8-11.

Lawson, D., M. Hampton, and C. Morewood. 1987. A modification of the Palmer Cap-chur gas-powered capture rifle. So. Afr. J. Wildl. Res. 17: 136-138.

Lawson, D. M., and D. Melton. 1989. A radio-tagged game capture dart. So. Afr. J. Wildl. Res. 19: 99-101.

LeBlanc, P. H., S. W. Eicker, M. Curtis, and B. Beehler. 1987. Hypertension following etorphine anesthesia in a rhinoceros (*Diceros simus*). J. Zoo An. Med. 18: 141-143.

Lee, A. F. 1981. Drugs, anesthetics and toxic conditions in alligators. Proc. Ann. Alligator Production Conf. 1: 52-57.

Lee, J., R. Schweinsburg, F. Kernan, and J. Haigh. 1981. Immobilization of polar bears (*Ursus maritimus*, Phipps) with ketamine hydrochloride and xylazine hydrochloride. J. Wildl. Dis. 17: 331-336.

Leege, T., and M. W. Schlegel. 1974. Study VI: Evaluation of long range immobilization equipment and new drugs on big game animals. Progress Report W-160-R. Idaho Fish and Game Pp. 21-22.

Lees, P., and C. J. Hillidge. 1976. Immobilon: some comments on its action. Vet. Rec. 99: 55-56.

Lemm, C. A. 1993. Evaluation of five anesthetics on striped bass. U. S. Fish & Wildl. Serv. Resource Pub. 196: 1-10.

Lentfer, J. W. 1968. A technique for immobilizing and marking polar bears. J. Wildl. Manage. 32: 317-321.

Lentz, W. M., R. L. Marchinton, L. B. Flynn, S, M. Shea, and P. J. Stuart. 1986. The immobilisation of sambar deer with succinylcholine chloride. Austrl. Deer 11: 3-11.

Letcher, J. D. 1992. Intracelomic use of tricaine methanesulfonate for anesthesia of bullfrogs (*Rana catesbeiana*) and leopard frogs (*Rana pipiens*). Zoo Biol. 11: 243-251.

Letcher, J. D., and S. Amsel. 1989. Practitioners guide to anesthesia in anurans. Compend. Anim. Pract. 19: 21-24.

Letcher, J., and R. Durante. 1995. Evaluation of use of tiletamine/zolazepam for anesthesia of bullfrogs and leopard frogs. J. Am. Vet. Med. Assoc. 207: 80-80-82.

Lewis, J. C. M. 1991. Reversible immobilisation of Asian small-clawed otters with medetomidine and ketamine. Vet. Rec. 128: 86-87.

Lewis, J. C. M. 1993. Medetomidine-ketamine anaesthesia in the chimpanzee (*Pan troglodytes*). J. Vet. Anaesth. 20: 18-20.

Lewis, J. W., K. W. Bentley, and A. Cowan. 1971. Narcotic analgesics and antagonists. Ann. Rev. Pharmacol. 11: 241-270.

Lewis, R. J., G. A. Chalmers, M. W. Barrett, and R. Bhatnagar. 1977. Capture myopathy in elk in Alberta, Canada: A report of three cases. J. Am. Vet. Med. Assoc. 171: 927-932.

Lietsch, C. D. 1969. L'immobilisation des elephants. Cahiers Bleus Veterinaries. 16: 35-39.

Lightfoote, W. E., and G. F. Molinari. 1978. Comparison of ketamine and pentobarbital anesthesia in the Mongolian gerbil. Am. J. Vet. Res. 39: 1061-1063.

Lin, H. C., J. C. Thurmon, G. J. Benson, and W. J. Tranquilli. 1993. Immobilization and anesthesia of two hand-reared zebras. J. Am. Vet. Med. Assoc. 202: 988-990.

Lindau, K. H., and M. Gorgas. 1969. Versuche mit Bay VA 1470. Int. Symp. Dis. Zoo and Wild An. Zagreb. 11: 135-137.

Ling, J. K., and D. G. Nicholls. 1963. Immobilization of elephant seals using succinylcholine chloride. Nature 200: 1021-1022.

Ling, J. K., D. G. Nicholls, and C. D. B. Thomas. 1967. Immobilization of southern elephant seals with succinylcholine chloride. J. Wildl. Manage. 31: 468-479.

Linn, K. 1986. Guidelines for avian anesthesia. Norden News. 61: 22-24.

Liscinsky, S. A., G. P. Howard, and R. B. Waldeisen. 1969. A new device for injecting powdered drugs. J. Wildl. Manage. 33: 1037-1038.

Litchford, R. G., and R. M. Durham. 1977. Surgery on a red-tailed hawk (*Buteo jamaicensis gmelin*). J. Tennesee Acad. Sci. 52: 110-111.

Lloyd, M. L., T. Reichard, and R. A. Odum. 1994. Gallamine reversal in Cuban crocodiles (*Crocodylus rhombifer*) using neostigmine alone versus neostigmine with hyaluronidase. Proc. Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. Pp. 117-120.

Lochmiller, R. L., and W. E. Grant. 1983. A sodium bicarbonate-acid powered blow-gun syringe for remote injection of wildlife. J. Wildl. Dis. 19: 48-51.

Lock, J. A., and A. M. Harthoorn. 1959a. A note on the use of suxamethonium chloride (succinylcholine chloride) for restraint of zebra. Vet. Rec. 71: 334.

Lock, J. A., and A. M. Harthoorn. 1959b. The use of succinylcholine chloride (suxamethonium chloride) for the control and management of wild animals. Vet. Rec. 71: 919-920.

Lockie, J. D., and M. G. Day. 1966. The use of anaesthesia in the handling of stoats and weasels. *In* Jones, O. G. (ed.). Symposium on Small Mammal Anesthesia. Pergamon Press, Oxford. Pp. 187-189.

Logan, K. A., E. T. Thorne, L. L. Irwin, and R. Skinner. 1986. Immobilizing wild mountain lions (*Felis concolor*) with ketamine hydrochloride and xylazine hydrochloride. J. Wildl. Dis. 22: 97-103.

Loibl, M. F., U. S. Clutton, B. D. Marx, and C. J. McGrath. 1988. Alpha-chloralose as a capture and restraint agent of birds: therapeutic index determination in the chicken. J. Wildl. Dis. 24: 684-687.

Loughlin, T. R., and T. Spraker. 1989. Use of Telazol to immobilize female northern sea lions (*Eumetopias jubatus*) in Alaska. J. Wildl. Dis. 25: 353-358.

Louw, A. J. 1957. The use of chlorpromazine hydrochloride (Largactil-Maybaker) in anesthesia of brown bear (*Ursus arctos*). J. So. Afr. Vet. Assoc. 28: 261-263.

Love, J. A. 1970. Use of fentanyl and droperidol in guinea pigs, lemmings, ground squirrels, and cats. J. Am. Vet. Med. Assoc. 157: 675-677.

Loveridge, J. P. 1979. The immobilization and anaesthesia of crocodilians. Int. Zoo Yb. 19: 103-112.

Loveridge, J. P., and D. K. Blake. 1972. Techniques in the immobilization and handling of the Nile crocodile, *Crocodylus niloticus*. Arnoldia (Rhod.). 40: 1-14.

Loveridge, J. P., and D. K. Blake. 1987. Crocodile immobilization and anaesthesia. *In* Webb, G. J. W., C. Manolis, P. and J. Whitehead (eds.). Wildlife Management: Crocodiles and Alligators. Surrey Beatty & Sons Pty Ltd, Chipping Norton, NSW, Australia. Pp. 259-267.

Lovett, J. W., and E. P. Hill. 1977. A transmitter syringe for recovery of immobilized deer. J. Wildl. Manage. 41: 313-315.

Low, R. J. 1973. Immobilon in deer. Vet. Rec. 93: 86-87.

Lu, J., C. Yu, C. Liang, Y. Ding, and D. Sun. 1992. A study on immobilization of Pere David's deer with miannaining. Forest research 5: 601-605 (Chinese).

Ludders, J. W., and A. D. Ojerio. 1980. Brief observations on handling and chemical restraint of the rat kangaroo (*Potorous tridactylus*). J. Zoo An. Med. 11: 106-108.

Ludders, J. W., C. J. Sedgwick, S. V. Manley, and S. S. Haskins. 1982. Anesthesia for restraint and transportation of five lowland gorillas (*Gorilla gorilla*). J. Zoo An. Med. 13: 78-81.

Ludders, J. W., J. A. Rode, and G. S. Mitchell. 1987. The effective dose and cardiopulmonary effects of isoflurane in sandhill cranes (*Grus canadensis*) during spontaneous ventilation. Vet. Surg. 16: 322.

Lumeij, J. T. 1986. Anesthetic fatalities in goshawks. Conf. Avian Dis. 5: 201-207.

Lydersen, C., D. Griffiths, I. Gjertz, and Ø. Wiig. 1992. A tritiated water experiment on male Atlantic walrus (*Odobenus rosmarus rosmarus*). Mar. Mamm. Sci. 8: 418-420.

Lynch, G. M., and J. A. Hanson. 1981. Use of etorphine to immobilize moose. J. Wildl. Manage. 45: 981-985.

Lynch, G. M., W. Hall, B. Pelchat, and J. A. Hanson. 1982. Chemical immobilization of black bear with special reference to the use of ketamine-xylazine. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 245-266.

Lynch, S., and S. Line. 1985. Failure of yohimbine to reverse ketamine anesthesia in rhesus monkeys. Lab. An. Sci. 35: 7-8.

Lyon, D. G., and D. C. Dinning. 1973. Veterinary laboratory - annual report 1973. North of England Zoological Society, Chester Zoological Gardens. Pp. 14-16.

Mac Lentz, W., R. L. Marchinton, L. B. Flynn, S. M. Shea, and P. J. Stuart. 1986. The immobilization of sambar deer with succinylcholine chloride. Austral. Deer. 11: 3-9.

Macek, D. 1987. Immobilization of some species of big game animals. Trans. Congr. Int. Union Game Biol. 18: 108-109.

Machado, C. R., C. W. Furley, and H. Hood. 1983. Observations on the use of M99, immobilon and xylazine in the Arabian oryx (*Oryx leucoryx*). J. Zoo An. Med. 14: 107-110.

MacKintosh, C. G. 1985. Potential antidote for Rompun (xylazine) in humans. N. Z. Med. J. 98: 714-715.

MacKintosh, C. G., and G. Van Reenen. 1984a. Yohimbine injection in deer. N. Z. Vet. J. 32: 217-218.

MacKintosh, C. G., and G. Van Reenen. 1984b. Comparison of yohimbine, 4-aminopyridine and doxapram antagonism of xylazine sedation in deer (*Cervus elaphus*). N. Z. Vet. J. 32: 181-184.

MacKintosh, C. G., J. A. MacArthur, T. W. A. Little, and P. Stuart. 1976. The immobilization of the badger (*Meles meles*). Br. Vet. J. 132: 609-614.

Maddock, A. H. 1989. Anaesthesia of four species of viverridae with ketamine. So. Afr. J. Wildl. Res. 19: 80-84.

Magonigle, R. A., E. H. Stauber, and H. W. Vaughn. 1977. The immobilization of wapiti with etorphine hydrochloride. J. Wildl. Dis. 13: 258-261.

Mainka, S. A., and T. He. 1993. Immobilization of healthy male giant pandas (*Ailuropoda melanoleuca*) at the Wolong nature reserve. J. Zoo Wildl. Med. 24: 430-433.

Majonica, I., and C. H. Bonath. 1993. Tiletamine-zolazepam immobilisation of East African oryx antelopes (*Oryx beisa callotis*). J. Vet. Anaesth. 20: 53.

Malmstrom, T., R. Salte, H. M. Gjoen, and A. Linseth. 1993. A practical evaluation of metomidate and MS-222 as anaesthetics for Atlantic halibut (*Hippoglossus hippoglossus* L.). Aquaculture 113: 331-338.

Mandelker, L. 1993. The dosages and drawbacks of propofol. Vet. Forum (Nov.). P. 36.

Manton, V. J. A. 1964. Immobilisation of wild animals. Vet. Rec. 76: 707-708.

Manton, V. J. A., and D. M. Jones. 1974. Scientific report 1971-1973, Whipsnade Park. J. Zool., Lond. 173: 84-97.

Marini, R. P., L. R. Jackson, M. I. Esteves, K. A. Andrutis, C. M. Goslant, and J. G. Fox. 1994. Effect of isoflurane on hematologic values in ferrets. Am. J. Vet. Res. 55: 1479-1483.

Maritz, T. 1993. Chemical capture of the hippopotamus *Hippopotamus amphibius*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 571-574.

Marlow, B. J. 1956. Chloral hydrate narcosis for the live capture of mammals. CSIRO Wildl. Res. 1: 63-65.

Marma, B. B. 1970. [Immobilizing roe deer for transportation]. Trans. Congr. Int. Union Game Biol. 9: 182-184.

Marsboom, R. 1969. On the pharmacology of azaperone, a neuroleptic for the restraint of wild animals. Acta Zool. Path. Antver. 48: 155-161.

Marsboom, R. 1985. Immobilization of wild animals with carfentanil - a review. Trans. Congr. Int. Union Game Biol. 17: 803-810.

Marsboom, R., J. Mortelmans, and J. Vercruysse. 1963. Neuroleptanalgesia in monkeys. Vet. Rec. 75: 132-133.

Marsboom, R., J. Mortelmans, and J. Vercruysse. 1964. A new hypnotic agent in birds. Int. Zoo Yb. 5: 200-201.

Marsboom, R., and J. Mortelmans. 1964. Some pharmacological aspects of analgesics and neuroleptiques and their use for neuroleptanalgesia in primates and lower monkeys. Sm. Anim. Anesth. Symp. London. Pp. 31-44.

Marsboom, R., J. Mortelmans, J. Vercruysse, and D. Thienpont. 1962. Effective sedation and anesthesia in gorillas and chimpanzee. Nord. Vet. Med. 14: 95-101.

Martin, L. L. 1967. Comparison of methoxymol, alpha-chloralose and two barbituates for capturing doves. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 21: 193-200.

Martyn, E. 1955. Pentobarbital sodium as an anesthetic for bears. J. Am. Vet. Med. Assoc. 127: 415.

Masangkay, J. S., T. Namikawa, V. G. Momongan, and R. Escalada. 1993. The use of xylazine for the restraint of captive tamaraw (*Bubalus mondorensis*). Phillipine J. Vet. Med. 30: 37-38.

Matschke, G. H., and V. G. Henry. 1969a. Immobilizing European wild hogs with Cap-Chur gun. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 23: 185-188.

Matschke, G. H., and V. G. Henry. 1969b. Immobilizing European wild hogs with succinylcholine chloride. J. Wildl. Manage. 33: 1039-1041.

Matthews, M. 1971. The use of ketamine to immobilize a black leopard. J. Zoo An. Med. 2: 25.

Matthews, M. 1977. Capturing desert bighorn sheep in Baja California, Mexico. J. Zoo An. Med. 8: 9-10.

Matthews, N. S., and M. W. Meyers. 1993. The use of tiletamine-zolazepam for darting feral horses. J. Equine Vet. Sci. 13: 264-267.

Matthews, N. S., K. R. Petrini, and P. L. Wolff. 1995. Anesthesia of Przewalski's horses (*Equus przewalskii przewalskii*) with medetomidine-ketamine and antagonism with atipamezole. J. Zoo Wildl. Med. 26: 231-236.

Mattingly, B. E. 1972. Injectable anesthetic for raptors. Raptor Res. 6: 51-52.

Mautz, W. W., U. S. Seal, and C. B. Boardman. 1980. Blood serum analyses of chemically and physically restrained white-tailed deer. J. Wildl. Manage. 44: 343-351.

Mazzi, A. 1994. Sedation and anaesthesia in wild Artiodactyla, Cervidae, Camelidae, Bovidae. Obiettivi e Documenti Veterinari 15: 11-17.

McAllum, H. J. 1977. Some veterinary techniques used in New Zealand deer farming. N. Z. Vet. J. 25: 130-131.

McCorquodale, S. M. Eberhardt, and S. E. Petron. 1988. Helicopter immobiliza-

tion of elk in southcentral Washington. Northwest Sci. 62: 49-52.
McDonnel, W. 1972. Anesthesia of the harp seal. J. Wildl. Dis. 8: 287-295.
McFarland, W. N., and G. W. Klontz. 1969. Anaesthesia in fishes. Fed. Proc. 28: 1535-1540.
McGrath, C. J., R. J. Farnsworth, E. A. Usenik, M. Wise, P. N. Ogburn, A. J. Crimi, M. Wright, M. R. Raffe, and N. Burtnick. 1979. Anesthesia in a California sea lion using a bain breathing circuit. J. Zoo An. Med. 10: 129-135.
McJames, S. W., I. L. Smith, T. H. Stanley, and G. Painter. 1993. Elk immobilization with potent opioids: A-3080 vs. carfentanil. Proc. Am. Assoc. Zoo Vet. Pp. 418-419.
McKean, T. A., and B. Magonigle. 1978. The effect of immobilization with M-99 plus acepromazine on physiological parameters of domestic goats. J. Wildl. Manage. 42: 176-179. 113
McKelvey, W. A. C., and C. A. Simpson. 1985. Reversal of the effects of xylazine and xylazine/ketamine in red deer. Vet. Rec. 117: 362-363.
McKenzie, A. A. 1989. Increasing the rate of recovery of projectile syringes and of animals darted at night. So. Afr. J. Vet. Res. 19: 85-86.
McKenzie, A. A. (ed.). 1993. The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. 729 pp.
McKenzie, A. A., and R. E. J. Burroughs. 1993. Chemical capture of carnivores. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 224-243.
McKintosh, C. G., and G. Van Reenen. 1984. Comparison of yohimbine, 4-aminopyridine and doxapram antagonism of xylazine sedation in deer (*Cervus elaphus*). New Zealand Vet. J. 32: 181-184.
McLaughlin, C. R. 1993. Notes on the use of Telazol® on denned black bears. Int. Bear News. 2: 1.
McWade, D. H. 1982. An evaluation of ketamine and xylazine in combination as agents for the remote chemical immobilization of feral and stray dogs. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 175-187.
Mech, L. D. 1965. Sodium pentobarbital as an anesthetic for raccoons. J. Mammal. 46: 343-344.
Mech, L. D. 1974. Current techniques in the study of elusive wilderness carnivores. Trans. Congr. Int. Union Game Biol. 11: 315-322.
Mech, L. D., and E. M. Gese. 1992. Field testing the Wildlink capture collar on wolves. Wildl. Soc. Bull. 20: 221-223.
Mech, L. D., R. C. Chapman, W. W. Cochran, L. Simmons, and U. S. Seal. 1984. Radio-triggered anesthetic-dart collar for recapturing large mammals. Wildl. Soc. Bull. 12: 69-74.
Mech, L. D., G. D. Del Giudice, P. D. Karns, and U. S. Seal. 1985. Yohimbine hydrochloride as an antagonist to xylazine hydrochloride-ketamine hydrochlo-

ride immobilization of white-tailed deer. J. Wildl. Dis. 21: 405-410.

Mech, L. D., K. Kunkel, R. C. Chapman, and T. J. Kreeger. 1990. Field testing of a commercially manufactured capture collar on white-tailed deer. J. Wildl. Manage. 54: 297-299.

Medway, W., J. G. McCormick, S. H. Ridgway, and J. F. Crump. 1970. Effects of prolonged halothane anesthesia on some cetaceans. J. Am. Vet. Med. Assoc. 157: 576-582.

Mehren, K. G., and W. A. Rapley. 1975. The use of Dopram to counteract the effects of Rompun-induced immobilization in captive ungulates. Proc. Am. Assoc. Zool. Parks Aquaria. Pp. 48-53.

Melby, E. C., and H. J. Baker. 1965. Phencyclidine and anesthesia in simian primates. J. Am. Vet. Med. Assoc. 147: 1068.

Melton, C. A. 1980. Baboon (*Papia ursinus*) capture using a blow-dart system. So. Afr. J. Wildl. Res. 10: 67-70.

Melton, D. A., and C. Melton. 1982. Immobilisation and blood analyses of baboons (*Papio ursinus*) in the Okavango swamp. Botswana Notes Rec. 13: 119-122.

Meltzer, D. G. A., R. Burroughs, F. G. Stegmann, A. R. Hargens, R. W. Millard, K. Johansen, D. H. Gershuni, K. Petterson, and W. Van Hoven. 1985. The capture and restraint of giraffe (*Giraffa camelopardalis*) for blood and interstitial fluid pressure studies. *In* Dawson, P. (ed.). Exotic Animals in Research. So. Afr. Assoc. Lab. Anim., Pretoria. Pp. 42-46.

Merriam, H. 1962. Immobilisation technique of free-ranging sitka black-tail deer in southeast Alaska. Alaska Dept. Fish Game Infor. Leafl. 18.

Meshcherskii, R. M., N. V. Menyailov, I. S. Shepeleva, I. I. Korenev, Y. A.Toporov, I. A. Gorelov, and I. S. Ivanov. 1978. Narcotization of the porpoises without blocking their own respiration. Zhurnal Evolyutsionnoi Biokhmii i Fiziologii. 14: 410-411.

Messel, H., and D. R. Stephens. 1980. Drug immobilization of crocodiles. J. Wildl. Manage. 44: 295-296.

Metcalfe, J., J. T. Parer, M. Rur, D. El-Yassin, J. Oufi, H. Bartels, K. Riegel, and E. Kleihauer. 1968. Cardiodynamics of the Dromedary camel (*Camelus dromedarius*) during phencyclidine analgesia. Am. J. Vet. Res. 29: 2063-2066.

Meuleman, T., J. D. Port, T. H. Stanley, K. F. Williard, and J. Kimball. 1984. Immobilization of elk and moose with carfentanil. J. Wildl. Manage. 48: 258-262.

Meyer, F. A. 1959. Use of tranquillizer drugs for moving bears at John Ball Zoo, U.S.A. Int. Zoo Yb. 2: 308-309.

Mikalsen, R., and J. M. Arnemo. 1993. Immobilization of elk with Rompun. Norsk Veterinaer. 105: 1230-1231.

Miller, F. L. 1968. Immobilization of free-ranging black-tailed deer with succinylcholine chloride. J. Wildl. Manage. 32: 195-197.

Miller, M. W., M. A. Wild, and W. R. Lance. 1996. Efficacy and safety of naltrexone hydrochloride for antagonizing carfentanil citrate immobilization in captive Rocky Mountain elk (Cervus elaphus nelsoni). J. Wildl. Dis. 32: 234-239.

Miller, R. L., and G. B. Will. 1974. The use of M99 etorphine and antagonists to immobilize and handle black bears. Third Int. Conf. Black Bears. Pp. 225-234.

Miller, R. L., and G. B. Will. 1976. The use of M99 etorphine and antagonists to immobilize and handle black bears. *In* Pelton, M. R., J. W. Lentfer, and G. E. Folk Jr. (eds.). Bears - Their Biology and Management. IUCN Publ. New Ser. 40. Pp. 247-260.

Miller, R. L., E. R. McCaffrey, and G. B. Will. 1973. Recent capture and handling techniques for black bears in New York. Trans. Northeast Fish Wildl. Conf. 30: 117-137.

Miller, R. M. 1979. Exotic carnivores. Vet. Clin. North Am. [Sm. Anim. Pract.]. 9: 569-580.

Miller-Edge, M., and S. Amsel. 1994. Carfentanil, ketamine, xylazine combination (CKX) for immobilization of exotic ungulates; clinical experience in bongo (*Tragelaphus euryceros*) and mountain tapir (*Tapirus pinchaque*). Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. Pp. 192-195.

Millspaugh, J. J., G. C. Brundige, J. A. Jenks, C. L. Tyner, and D. R. Hunstead. 1995. Immobilization of Rocky Mountain elk with Telazol® and xylazine hydrochloride, and antagonism by yohimbine hydrochloride. J. Wildl. Dis. 31: 259-262.

Mitchell, P. J., and H. R. Burton. 1991. Immobilization of southern elephant seals and leopard seals with cyclohexamine anaesthetics and xylazine. Vet. Rec. 129: 332-336.

Moller, H. 1983. An apparatus for anaesthetizing small mammals. J. Zool. London. 201: 579-581.

Montgomery, G. G. 1961. A modification of the nicotine dart capture method. J. Wildl. Manage. 25: 101-102.

Montgomery, G. G, and R. E. Hawkins. 1967. Diazepam baiting for capture of white-tailed deer. J. Wildl. Manage. 31: 464-468.

Moon, P. F., and E. K. Stabenau. 1996. Anesthetic and postanesthetic management of sea turtles. J. Am. Vet. Med. Assoc. 208: 720-726.

Moran, J. F., F. Ballesteros, P. Quiros, and J. Benito. 1994. Immobilization of wild Spanish Cantabrian chamois (*Rupicapra rupicapra*). J. Vet. Anaesth. 21: abstract.

More, G. 1977. Immobilization of marten with sodium pentobarbital. J. Wildl. Manage. 41: 796-798.

Moreland, A. F., and C. Glaser. 1985. Evaluation of ketamine, ketamine-xylazine and ketamine-diazepam anesthesia in the ferret. Lab. An. Sci. 35: 287-290.

Morgan, R. J., L. B. Eddy, T. N. Solie, and C. C. Turbes. 1981. Ketamine-acepromazine as an anaesthetic agent for chinchillas (*Chinchilla laniger*). Lab. An. 15: 281-283.

Morgan-Davies, A. M. 1980. Immobilization of the Nile crocodile (*Crocodilus niloticus*) with gallamine triethiodine. J. Zoo An. Med. 11: 85-87.

Morkel, P. 1989. Drugs and dosages for capture and treatment of black rhinoceros *Diceros bicornis* in Namibia. Koedoe 10: 65-68.

Morkel, P. 1992a. Depot neuroleptics in roan antelope. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 38-39.

Morkel, P. 1992b. Giraffe capture with etorphine HCL (M-99) and hyalase - a new approach. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 58-59.

Morkel, P. 1993a. Prevention and management of capture drug accidents. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 100-115.

Morkel, P. 1993b. Chemical capture of the giraffe *Giraffa camelopardalis*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 601-606.

Morley, J. E. 1981. The endocrinology of the opiates and opioid peptides. Metabolism. 30: 195-209.

Morris, M. A. 1986. Anesthesia of snakes (*Pituophis melanoleucus* and *Python regius*) fed ether-killed rats. Herpertol. Rev. 17: 88.

Morris, P. J. 1992. Evaluation of potential adjuncts for equine chemical immobilization. Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. Pp. 235-250.

Mortelmans, J. 1971. L'Anesthesie des animaux sauvages. Ann. Med. Vet. 5: 317-332.

Mortelmans, J. 1978. Anesthesia in okapis. Acta Zool. Pathol. Antverpiensia. 71: 41-44.

Mortelmans, J., and J. Vercruysse. 1971. Immobilization and analgesia in wild animals in captivity. Int. Symp. Dis. Zoo and Wild An. Pp. 203-204.

Mortelmans, J., J. Vercruysse, D. Thienpont, R. Marsboom, R. Van Brabant, and B. Van Puÿenbroeck. 1972. Immobilisation, analgésie et narcose chez ruminants sauvages en captivité. Verhandlungsber. XIII. Symp. Erkankungen Zootiere, Helsinki. Pp. 125-129.

Mortenson, J. 1994. Oral carfentanil citrate use in white-handed gibbons (*Hylobates lar*). Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. P. 163.

Morton, D. J., and M. D. Kock. 1991. Stability of hyaluronidase in solution with etorphine and xylazine. J. Zoo Wildl. Med. 22: 345-347.

Mosby, H. S., and D. E. Canter. 1956. The use of Avertin in capturing wild turkeys and as an oral-based anesthetic for other wild animals. Southwest. Vet. 9: 132-136.

Mugera, G. M., and J. G. Wandera. 1967. Degenerative polymyopathies in East African domestic and wild animals. Vet. Rec. 80: 410-413.

Mulder, J. B. 1978a. Anesthesia in the coyote using a combination of ketamine and xylazine. J. Wildl. Dis. 14: 501-502.

Mulder, J. B. 1978b. Anesthesia in the mouse using a combination of ketamine and promazine. Lab. An. Sci. 28: 70-71.

Mulder, J. B., and H. B. Johnson. 1978. Ketamine and promazine for anesthesia in

the rat. J. Am. Vet. Med. Assoc. 173: 1152-1153.

Mulder, J. B., and J. J. Hauser. 1984. A device for anesthesia and restraint of snakes. Vet. Med. Small Anim. Clin. 79: 936-937.

Mulder, J. B., H. B. Johnson, G. S. McKee, and S. E. Sellers. 1979. Anesthesia with Ketaset Plus in guinea pigs and hamsters. Vet. Med. Sm. Anim. Clin. 1807-1808.

Mülling, M., and H. Henning. 1971. The use of Bay Va 1470 ("Rompun") for the capture of wild animals (Red, Fallow and Roe deer). Vet. Med. Rev. 1: 73-83.

Muraleedharan, K. N., K. Chandrasekharan, J. V. Cheeran, and K. Radhakrishnan. 1979. General anaesthesia in an elephant (*Elephas maximus*) - a clinical case report. Kerala J. Vet. Sci. 10: 197-200.

Murdoch, C. A. 1971. A history of the syringe weapon. Tussock Grassl. Mt. Lakes Inst. Rev. 21: 22-30.

Murray, M. G., A. R. Lewis, and A. M. Coetzee. 1981. An evaluation of capture techniques for research on impala populations. So. Afr. J. Wildl. Res. 11: 105-109.

Murry, R. E. 1964. Tranquilized deer. Louisiana Conservationist 14: 8-9.

Murry, R. E. 1965. Tranquilizing techniques for capturing deer. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 19: 4-15.

Murry, R. E., and D. Dennett. 1963. A preliminary report on the use of tranquilizing compounds in capturing wildlife. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 17: 134-139.

Murton, R. K., A. J. Isaacson, and N. J. Westwood. 1963. The use of baits treated with α-chloralose to catch wood-pigeons. Ann. Appl. Biol. 52: 271-293.

Murton, R. K., A. J. Isaacson, and N. J. Westwood. 1965. Capturing columbids at the nest with stupefying baits. J. Wildl. Manage. 29: 647-649.

Naccarato, E. F., and W. S. Hunter. 1979. Anaesthetic effects of various ratios of ketamine and xylazine in rhesus monkeys (*Macaca mulatta*). Lab. An. 13: 317-319.

Nagel, E. L., P. J. Morgane, and W. L. McFarland. 1964. Anesthesia for the bottlenose dolphin, *Tursiops truncatus*. Science 146: 1591.

Nair, N. R. 1977. The art of scientific immobilisation of animals. Indian Forester. 103: 64-79.

Neal, L. A., R. S. Custer, and M. Bush. 1981. Ketamine anesthesia in pigeons (*Columba livia*): Arterial blood gas and acid-base status. J. Zoo An. Med. 12: 48-51.

Nesbitt, S. A. 1976. Capturing sandhill crane with oral tranquilizers. Proc. Int. Crane Workshop. 1: 296-298.

Nesbitt, S. A. 1984. Effects of an oral tranquilizer on survival of sandhill cranes. Wildl. Soc. Bull. 12: 387-388.

Nesterov, G. A. 1972. [Observations on survival periods of fur seals after ditilinum injection]. Izv. Tikhookean. Nauchno-Issled. Inst. Rybn. Khoz. Okeanogr. 70: 232-233.

Nevalainen, T., L. Pyhälä, H.-M. Voipio, and R. Virtanen. 1989. Evaluation of anesthetic potency of medetomidine-ketamine combination in rate, guinea pigs

and rabbits. Acta Vet. Scand. Suppl. 85. Pp. 139-143.

Ngai, S. H., B. A. Berkowitz, J. C. Yang, J. Hempstead, and S. Spector. 1976. Pharmacokinetics of naloxone in rats and in man. Anesthesiology. 44: 398-401.

Nichols, D. K., and E. W. Lamirande. 1994. Use of methohexital sodium as an anesthetic in two species of colubrid snakes. Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. Pp. 161-162.

Nicholls, P. K., T. A. Bailey, C. A. Baker, and K. Wilson. 1996. Anesthesia of the grey duiker (*Sylvicapra grimmia*) using a combination of ketamine and xylazine with reversal by atipamezole. J. Zoo Wldl. Med. 27: 49-53.

Nielsen, L. 1982a. Chemical Immobilization in Urban Animal Control Work. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. 93 pp.

Nielsen, L. 1982b. Electronic ground tracking of white-tailed deer chemically immobilized with a combination of etorphine and xylazine hydrochloride. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 355-362.

Nielsen, L. 1982c. The use of chemical immobilization in urban animal control work. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. pp. 165-174.

Nielsen, L. 1984. Chemical capture of stray and feral animals, part II. Community Animal Control. Pp. 11-29.

Nielsen, L., J. C. Haigh, and M. E. Fowler (eds). 1982. Chemical immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. 447 pp.

Nielson, A. E., and W. M. Shaw. 1967. A helicopter dart technique for capturing moose. Proc. Western Assoc. Game Fish Comm. 47: 182-199.

Nordan, H. C., A. J. Wood, and I. M. Cowan. 1962. Further studies on the immobilization of deer with succinylcholine. Can. J. Comp. Med. Vet. Sci. 26: 246-248.

Norment, J. L., C. L. Elliot, and P. S. Costello. 1994. Another look at chemical immobilization of raccoons (*Procyon lotor*) with ketamine hydrochloride. J. Wildl. Dis. 30: 541-544.

Nowak, R. M. 1991. Walker's Mammals of the World. The Johns Hopkins University Press, Baltimore. 1,629 pp.

Noyes, D. H., and D. M. Siekierski. 1975. Anesthesia of marmots with sodium pentobarbital, ketamine hydrochloride, and a combination of droperidol and fentanyl. Lab. An. Sci. 25: 557-562.

Øen, E. O. 1980. Drug immobilization and anaesthesia of a lynx in connection with a broken leg. Nord. Vet. Med. 32: 318-320.

Øen, E. O. 1982. A new darting gun for the capture of wild animals. Nord. Vet. Med. 34: 39-43.

O'Gara, B. W. 1987. A preliminary evaluation of carfentanil citrate and xylazine hydrochloride for immobilizing pronghorns. Wildl. Soc. Bull. 15: 549-551.

Ogunranti, J. O. 1987. Some physiological observation on ketamine hydrochloride anaesthesia in the agamid lizard. Lab. An. 21: 183-187.

Okaeme, A. N., E. A. Agbelusi, J. Mshelbwala, M. Wari, A. Ngulge, and M. Haliru. 1988. Effects of immobilon and revivon in the immobilization of Western kob (*Kobus kob kob*). Afr. J. Ecol. 26: 63-67.

Olsen, C. D., and L. A. Renecker. 1985. Xylazine immobilization of wapiti: antagonism with yohimbine and 4-aminopyridine. *In* Nelson, R. W. (ed.). Proc. 1984 Western States and Provinces Elk Workshop. P. 176.

Olson, M. E., and K. McCabe. 1986. Anesthesia in the Richardson's ground squirrel: comparison of ketamine, ketamine and xylazine, droperidol and fentanyl, and sodium pentobarbital. J. Am. Vet. Med. Assoc. 189: 1035-1037.

Oosterhuis, J. E. 1979. Immobilization of nondomestic equidae at the San Diego wild animal park (1975-1979). Proc. Am. Assoc. Zoo Vet. Pp. 118-119.

Oppenheim, Y. C., and P. F. Moon. 1995. Sedative effects of midazolam in red-eared slider turtles (*Trachemys scripta elegans*). J. Zoo Wildl. Med. 26: 409-413.

Orbanyi, I. 1972. Kiserletek nehany emlosfaj immobilizalasara. [Experiments for the immobilization of some mammal species]. Allattani Kozl. 59: 111-117.

Orr, C. M. 1977. Accidental self-injection. Vet. Rec. 100: 574.

Orr, D. J. C., and S. M. Moore-Gilbert. 1964. Field immobilisation of young wildebeest with succinylcholine chloride. East Africa Wildl. J. 2: 60-66.

Ortega, J. J. Z., and J. I. Otter. 1967. Phencyclidine for capture of stray dogs. J. Am. Vet. Med. Assoc. 150: 772-776.

Osen, H., J. M. Arnemo, and N. J. C. Tyler. 1994. Sedation with medetomidine and its reversal with atipamezole reduces voluntary food intake in reindeer. 3d Intl. Congr. Biol. Deer, Edinburgh, Scotland (Abstract).

Osofsky, S. A. 1995. Pulse oximetry monitoring of free-ranging African elephants (*Loxodonta africana*) immobilized with an etorphine/hyaluronidase combination antagonized with diprenorphine. Proc. Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 273-277.

Osofsky, S. A., J. W. McNutt, and K. J. Hirsch. 1995. Immobilization and monitoring of free-ranging wild dogs (*Lycaon pictus*) using a ketamine/xylazine/atropine combination, yohimbine reversal and pulse oximetry. Proc. Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 278-279.

Pade, K. 1974. Ein Beitrag zur Immobilisation von Zootieren. Kleintierpraxis 19: 249-280.

Page, C. D. 1986. Sloth bear immobilization with a ketamine-xylazine combination: reversal with yohimbine. J. Am. Vet. Med. Assoc. 189: 1050-1051.

Page, C. D. 1993. Current reptilian anesthesia procedures. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 140-143.

Palomares, F., and M. Delibes. 1992. Immobilization of Egyptian mongooses *Herpestes ichneumon* with a combination of ketamine and xylazine. Zeitschrift

fuer Saeugetierkunde 57: 251-252.

Palomares, F. 1993. Immobilization of common genets, *Genetta genetta*, with a combination of ketamine and xylazine. J. Wildl. Dis. 29: 174-176.

Paponov, V. A. 1978. Immobilization of sika deer (*Cervus nippon hortulorum* S.) by means of a ditillin (anectin) paste. Congr. Theriol. Int. 2: 305.

Parker, J. B. R., and J. C Haigh. 1982. Human exposure to immobilizing agents. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 119-136.

Parry, K., S. S. Anderson, and M. A. Fedak. 1981. Chemical immobilization of gray seals. J. Wildl. Manage. 45: 986-990.

Patenaude, R. P. 1979. Evaluation of fentanyl citrate, etorphine hydrochloride, and naloxone hydrochloride in captive polar bears. J. Am. Vet. Med. Assoc. 175: 1006-1007.

Patenaude, R. P. 1982a. Chemical immobilization of North American caribou. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. pp. 370-379.

Patenaude, R. P. 1982b. Chemical immobilization of North American muskox. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisoconsin. pp. 439-447.

Pathak, S. C., A. Mukit, J. Saikia, and J. Lekharu. 1985. Excision of a leiomyofibroma in a leopard (*Panthera pardus*) under ketamine anesthesia. J. Zoo An. Med. 16: 125-126.

Patrick, D. 1971. Immobilisation of topi. East African Wildl. J. 9: 152.

Payton, A. J., and J. R. Pick. 1989. Evaluation of a combination of tiletamine and zolazepam as an anesthetic for ferrets. Lab. An. Sci. 39: 243-246.

Pearce, P. C., C. Gustavo, F. Gulland, and J. Knight. 1985. Immobilization of pygmy hippopotamus (*Choeropsis liberiensis*). J. Zoo An. Med. 16: 104-106.

Pearce, P. C., L. Dorr, and R. Kock. 1985. "Anaesthetic death" in a black fallow deer. Vet. Rec. 116: 591-593.

Pearce, P. C., and R. Kock. 1989a. Physiological effects of etorphine, acepromazine and xylazine on black fallow deer (*Dama dama*). Res. Vet. Sci. 46: 380-386.

Pearce, P. C., and R. Kock. 1989b. Physiological effects of etorphine, acepromazine and xylazine on scimitar horned oryx (*Oryx dammaha*). Res. Vet. Sci. 47: 78-83.

Pearson, A. M., R. M. Bradley, and R. T. McLaughlin. 1968. Evaluation of phencyclidine hydrochloride and other drugs for immobilizing grizzly and black bears. J. Wildl. Manage. 32: 532-537.

Pearson, A. M., and D. W. Halloran.1972. Hematology of the brown bear (*Ursus arctos*) from southwestern Yukon Territory, Canada. Can. J. Zool. 50: 279-286.

Pearson, H. A., A. D. Smith, and P. J. Urness. 1963. Effects of succinylcholine chloride on mule deer. J. Wildl. Manage. 27: 297-299.

Pedersen, R. J., and J. W. Thomas. 1975. Immobilization of Rocky Mountain elk using powdered succinylcholine chloride. U.S. For. Ser. Res. Note. PNW 240: 4.

Pedersoli, W. M. 1970. The use of drugs in the capture and restraint of wild animals. Auburn Vet. Pp. 57-59, 84-85.

Peek, F. W. 1972. The effect of tranquilization upon territory maintenance in the male red-winged blackbird (*Agelaius phoeniceus*). An. Behav. 20: 119-122.

Peek, J. M. 1966. Chlordiazepoxide and pentobarbital as tranquilizers for cowbirds and coturnix quail. J. Am. Vet. Med. Assoc. 149: 950-952.

Pemberton, D., and N. Gales. 1991. Field immobilization of Tasmanian devils (*Sarcophilus harrisii*) with ketamine hydrochloride and xylazine hydrochloride. Wildl. Res. 18: 695-698.

Perry, J. L. 1977. Remote immobilization of bears with Ketaset® and mixtures of Rompun®and Ketaset®. Border Grizzly Project Field Report. No. 35.

Pertz, C., and J. P. Sundberg. 1978. Malignant hyperthermia induced by etorphine and xylazine in a fallow deer. J. Am. Vet. Med. Assoc. 173: 1243.

Peshin, P. K., J. M. Nigam, S. C. Singh, and B. A. Robinson. 1980. Evaluation of xylazine in camels. J. Am. Vet. Med. Assoc. 177: 875-878.

Peshin, P. K., J. Singh, A. P. Singh, and D. B. Patil. 1992. Experimental and clinical evaluation of some sedatives and anaesthetic agents in dromedary camels (*Camelus dromedarius*). *In* Allen W. R., A. J. Higgins, I. G. Mayhew, D. H. Snow, and J. F. Wade. (eds.). Proc. First International Camel Conference, Dubai. Pp. 371-374.

Peterson, R. S. 1965. Drugs for handling fur seals. J. Wildl. Manage. 29: 688-693.

Petrini, K. 1992. The medical management and diseases of mustelids. Proc. Am. Assoc. Zoo Vet. Pp. 116-135.

Petrini, K. R., D. E. Keyler, L. Ling, and D. Borys. 1993. Immobilization agents – developing an urgent response protocol for human exposure. Proc. Am. Assoc. Zoo Vet. Pp. 147-154.

Phelan, J. R., and K. Green. 1992. Chemical restraint of Weddell seals (*Leptonychotes weddellii*) with a combination of tiletamine and zolazepam. J. Wildl. Dis. 28: 230-235.

Philo, L. M. 1978. Evaluation of xylazine for chemical restraint of captive Arctic wolves. J. Am. Vet. Med. Assoc. 173: 1163-1166.

Pienaar, U. de V. 1963. Elephant control in National Parks: a new approach. Oryx. 7: 35-38.

Pienaar, U. de V. 1967a. The field immobilization and capture of hippopotami (*Hippopotamus amphibius linnaeus*) in their aquatic elements. Koedoe. 10: 149-157.

Pienaar, U. de V. 1967b. Operation "Khomandlopfu" (capture the elephants). Koedoe 10: 158-164.

Pienaar, U. de V. 1968a. Recent advances in the field immobilization and restraint of wild ungulates in South African national parks. Acta Zool. Pathol. Antverp. 46: 17-38.

Pienaar, U. de V. 1968b. The use of the immobilizing drugs in conservation proce-

dures for roan antelope. Acta Zool. Pathol. Antwerp. 46: 39-51.

Pienaar, U. de V. 1969a. The use of drugs in the field immobilization and restraint of large wild mammals in South African national parks. Acta Zool. Pathol. Antwerp. 48: 163-177.

Pienaar, U. de V. 1969b. Capture and immobilization techniques currently employed in South African national parks and reserves. *In* Golley, F. B., and H. K. Buechner (eds.). A Practical Guide to the Study of the Productivity of Large Herbivores. Blackwell Scientific, Oxford. Pp. 132-144.

Pienaar, U. de V. 1970. The drug-immobilizing technique on the game farm or ranch. Game Owners Assoc. of So. Afr. and S.W. Afr. Information Sheet No. 1. 9 pp.

Pienaar, U. de V. 1973a. The drug immobilization of antelope species. *In* Young, E. (ed.). The Capture and Care of Wild Animals. Human and Rousseau, Cape Town, South Africa. Pp. 35-50.

Pienaar, U. de V. 1973b. Darting and injection equipment and techniques. *In* Young, E. (ed.). The Capture and Care of Wild Animals. Human and Rousseau, Cape Town, South Africa. Pp. 7-13.

Pienaar, U. de V., and J. W. Van Niekerk. 1963. The capture and translocation of three species of wild ungulates in the Eastern Transvall with special reference to R05-2807/B-SF (Roache) as a tranquillizer in game animals. Koedoe 6: 83-91.

Pienaar, U. de V., and N. Fairall. 1963. A preliminary note on the use of Quiloflex (Benzodioxane hydrochloride) in the immobilization of game. Koedoe 6: 109-115.

Pienaar, U. de V., J. W. Van Niekerk, E. Young, P. Van Wyk, and N. Fairall. 1966a. Neuroleptic narcosis of large wild herbivores in South African national parks with the new potent morphine analogues M.99 and M.183. J. So. Afr. Vet. Assoc. 37: 277-291.

Pienaar, U. de V., J. W. Van Niekerk, E. Young, P. Van Wyk, and N. Fairall. 1966b. The use of oripavine hydrochloride (M99) in the drug immobilization and marking of wild African elephant (*Loxodonta africana*) in the Kruger National Parks. Koedoe 9: 108-123.

Pienaar, U. de V., E. Le Riche, and C. S. Le Roux. 1969. The use of drugs in the management and control of large carnivorous mammals. Koedoe 12: 177-183.

Pietrak, M. 1992. Pharmacolgical restraint (immobilization) of reptiles. Magazyn Weterynaryjny 1: 42-43. (Polish)

Pietrak, M. 1994. Palmer's rifle - equipment for application of drugs to wild or zoo animals. Magazyn Weterynaryjny 3: 48-49. (Polish)

Pigozzi, G. 1987. Immobilization of crested porcupines with xylazine hydrochloride and ketamine hydrochloride. J. Wildl. Manage. 51: 120-123.

Pigozzi, G. 1988. The capture and immobilization of the European badger, *Meles meles* (L.), in its natural environment. Atti Soc. Ital. Sci. Nat. Mus. Civ. Stor. Nat. Milano. 129: 56-70.

Pimlott, D. G., and L. W. J. Carberry. 1958 North American moose transplanta-

tions and handling techniques. J. Wildl. Manage. 22: 51-62.

Pinchin, A. 1993. Zimbabwe's rhino dehorning programme. Intl. Zoo News 40: 9-13.

Pistey, W. R., and J. F Wright. 1959. Immobilization of captive wild animals. Vet. Med. 54: 446-449.

Pistey, W. R., and J. F. Wright. 1961. The immobilization of captive wild animals with succinylcholine. Can. J. Comp. Med. Vet. Sci.. 25: 59-68.

Piwowarczyk, S. 1967. Narcosis induced in European bison by means of chloral hydrate and ethyl alcohol. Acta Theriol. 32: 467-470.

Player, I. C. 1967. The translocation of the white rhinoceros: a success in wildlife conservation in South Africa. Oryx 60: 137-150.

Plotka, E. D., U. S. Seal, T. C. Eagle, C. S. Asa, J. R. Tester, and D. B. Siniff. 1987. Rapid reversible immobilizations of feral stallions using etorphine hydrochloride, xylazine hydrochloride and atropine sulfate. J. Wildl. Dis. 23: 471-478.

Poklis, A., M. A. Mackell, and M. E. S. Case. 1985. Xylazine in human tissues and fluids in a case of fatal drug abuse. J. Analyt. Toxicol. 9: 234-236.

Pokras, M. A., and C. J. Sedgwick. 1990. Wildlife emergencies: how to cope with them before they happen. *In* D. R. Ludwig (ed.). Wildlife Rehabilitation. Eighth Ann. Symp. Natl. Wildl. Rehabilitators Assoc. Ithaca, New York. Pp. 117-133.

Pomeroy, D. E., and M. H. Woodford. 1976. Drug immobilization of marabou storks. J. Wildl. Manage. 40: 177-179.

Pond, D. B., and B. W. O'Gara. 1994. Chemical immobilization of large mammals. *In* Bookhout, T. A. (ed.). Research and Management Techniques for Wildlife and Habitats. The Wildlife Society, Bethesda, Md. Pp. 125-139.

Poole, K. G., G. Mowat, and B. G. Slough. 1993. Chemical immobilization of lynx. Wildl. Soc. Bull. 21: 136-140.

Porter, W. P. 1982a. Hematologic and other effects of ketamine and ketamine-acepromazine in rhesus monkeys (*Macaca mulatta*). Lab. An. Sci. 32: 373-375. 731

Porter, W. P. 1982b. A comparison of hematologic and other parameters while rhesus monkeys (*Macaca mulatta*) are immobilized with ketamine vs. ketamine combined with acepromazine. Lab. An. Sci. 32: 438. 379

Pospisil, J., F. Kase, and J. Vahala. 1989. Comparison of basic haematological values in grevy's zebra (*Equus grevyi*) during the summer and winter seasons. Comp. Biochem. Physiol. 92: 31-32.

Post, G. 1959. The use of curare and curare-like drugs on elk (wapiti). J. Wildl. Manage. 23: 365-366.

Presidente, P. J. A., and M. Draisma. 1978. The capture, sedation and immobilisation of wild ungulates, with special reference to deer. Part I. Post capture problems. Aust. Deer 3(2): 29-32.

Presidente, P. J. A., J. H. Lumsden, D. R. Presnell, W. A. Rapley, and B. M. McCraw. 1973. Combination of etorphine and xylazine in captive white-tailed deer: II. Effects on hematologic, serum biochemical and blood gas values. J. Wildl. Dis. 9: 342-348.

Presidente, P. J. A., P. G. Taylor, and M. Draisma. 1978a. The capture, sedation and immobilisation of wild ungulates, with special reference to deer. Part II. Mechanical means of capture. Aust. Deer 3(3): 27-32.

Presidente, P. J. A., R. Butler, R. Horsey, M. Draisma, P. G. Taylor, and P. Stuart. 1978b. The capture, sedation and immobilisation of wild ungulates, with special reference to deer. Part III. Drugs, projectile systems and their application. Aust. Deer 3(4): 27-40.

Presnell, K. R., P. J. S. Presidente, and W. A. Rapley. 1973. Combination of etorphine and xylazine in captive white-tailed deer: I. Sedative and immobilization properties. J. Wildl. Dis. 9: 236-341.

Prinsloo, M., and H. Ebedes. 1992. The use of some long-acting neuroleptics in wildlife captured with the "pop-up corral." *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 49-51.

Puri, C. P., V. Puri, and T. C. Anand Kumar. 1981. Serum levels of testosterone, cortisol, prolactin and bioactive luteinizing hormone in adult male rhesus monkeys following cage-restraint or anaesthetizing with ketamine hydrochloride. Acta Endocrinol. 97: 118-124.

Pusateri, F. M., C. P. Hibler, and T. M. Pojar. 1982. Oral administration of diazepam and promazine hydrochloride to immobilize pronghorn. J. Wildl. Dis. 18: 9-16.

Pybus, M. J., and D. K. Onderka. 1992. On the proper use of succinycholine in elk. J. Wildl. Dis. 28: 685 (letter).

Qiu, X. 1990. Anesthesia of the giant panda. J. Sichuan Teachers College 11: 114-117. (Chinese)

Quintana, F., C. Campagna, and R. Werner. 1992. Aspectos practicos de la anestesia de elefantes marinos en condiciones de campo. 5 Reunion de Trabajos de Especialistas en Mamiferos Acuaticos de America del Sur. Buenos Aires, Argentina.

Raath, J. P. 1993. Chemical capture of the African elephant *Loxodonta africana*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 484-492.

Raath, J. P., and C. M. Knox. 1989. The use of tranquilizers in confining newly captured impalas to bomas. Proc. Am. Assoc. Zoo Vet. P. 15.

Raath, J. P., S. K. F. Quandt, and J. H. Malan. 1992. Ostrich (*Struthio camelus*) immobilization using carfentanil and xylazine and reversal with yohimbine and naltrexone. J. So. Afr. Vet. Assoc. 63: 138-140.

Raath, J. P., C. M. Knox, D. Kernes, D. F. Keet, and M. G. L. Mills. 1995. Anesthesia of free-ranging wild dogs (*Lycaon pictus*) with fentanyl and xylazine. Proc. Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 287-289.

Ramsay, M. A., and I. Stirling. 1986. Long-term effects of drugging and handling free-ranging polar bears. J. Wildl. Manage. 50: 619-626.

Ramsay, M. A., I. Stirling, L. Ø. Knutsen, and E. Broughton. 1985. Use of yohimbine

hydrochloride to reverse immobilization of polar bears by ketamine hydrochloride and xylazine hydrochloride. J. Wildl. Dis. 21: 396-400.

Ramsay, E. C., J. M. Sleeman, V. L. Clyde, and D. Gieser. 1994. Immobilization of bears using orally administered carfentanil citrate. Joint Conf. Am. Assoc. Zoo Vet. Assoc. Reptil. Amphib. Vet. P. 214.

Ramsay, E. C., J. M. Sleeman, and V. L. Clyde. 1995. Immobilization of black bears (*Ursus americanus*) with orally administered carfentanil citrate. J. Wildl. Dis. 31: 391-393.

Ramsden, R. O., P. F. Coppin, and D. H. Johnston. 1976. Clinical observations on the use of ketamine hydrochloride in wild carnivores. J. Wildl. Dis. 12: 221-225.

Rapley, W. A., K. G. Mehren, C. J. Bonar, and G. B. Topolie. 1975. Repair of a fractured mandible in a giraffe using Rompun and M99 immobilization. Proc. Am. Assoc. Zoo Vet. Pp. 12-15.

Rapley, W. A., and K. G. Mehren. 1975. The clinical usage of Rompun (xylazine) in captive ungulates at the Metropolitan Toronto Zoo. Proc. Am. Assoc. Zoo Vet. Pp. 16-39.

Ratcliffe, H. L. 1962. Diazepam (tranimal) as a tranquilizer for zoo animals. Report of the Penrose Research Laboratory, Zoological Society of Philadelphia. Pp. 10-13.

Rathore, A. K. 1984. Use of alphachloralose in restraining dogs. Proc. Int. Conf. Wildl. Dis. Assoc. 4: 145-148.

Ratti, P., and K. Zeeb. 1972. Practical experience with Rompun® in the immobilization of game. Vet. Med. Rev. 3: 226-238.

Rausch, R. A., and R. W. Ritcey. 1961. Narcosis of moose with nicotine. J. Wildl. Manage. 25: 326-328.

Reddacliff, G. L. 1979. Home-made projectile syringes. N. Z. Vet. J. 27: 249-250.

Redig, P. T., A. A. Larson, and G. E. Duke. 1984. Response of great horned owls given the optical isomers of ketamine. Am. J. Vet. Res. 45: 125-127.

Redig, P. T., and G. E. Duke. 1976. Intravenously administered ketamine HCl and diazepam for anesthesia of raptors. J. Am. Vet. Med. Assoc. 169: 886-888.

Reed, G. T. 1978. Immobilization of two captive Nile hippo (*Hippopotamus amphibius*). Proc. Am. Assoc. Zoo Vet. Pp. 150-153.

Reich, D. L., and G. Silvay. 1989. Ketamine: an update on the first twenty-five years of clinical experience. Can. J. Anaes. 36: 186-197.

Renecker, L. A., and C. A. Olsen. 1985. Use of yohimbine and 4-aminopyridine to antagonize xylazine-induced immobilization in North American cervidae. J. Am. Vet. Med. Assoc. 187: 1199-1201.

Renecker, L. A., and C. A. Olsen. 1986. Antagonism of xylazine hydrochloride with yohimbine hydrochloride and 4-aminopyridine in captive wapiti. J. Wildl. Dis. 22: 91-96.

Renecker, L. A., J. Bertwistle, H. M. Kozak, R. J. Hudson, D. Chabot, and S. MacLean. 1992. R51163 as a sedative for handling and transporting plains bison and wapiti. J. Wildl. Dis. 28: 236-241.

Rerabek, J. 1954. The use of curare for capturing deer. Prace Vyskumaych Ustav

Lesnickych 7: 199-212
Reuben, D. 1966. Valium as a tranquilizer in zoo animals. Int. Zoo Yb. 6: 270.
Reuss von, Prinz Heinrich III. 1966. Beitrag zum Immobilisierung von Rot- und Rehwild. Tierärtstl. Umsch. 21: 559-565.
Reuther, V. C. 1983. [Experiences with the immobilization of the European otter (*Lutra lutra*) with ketamine hydrochloride. Berl. Munch. Tierarztl. Wochenschr. 96: 401-405.
Reuther, V. C., and B. Brandes. 1984. [Occurrence of hyperthermia during the immobilisation of European otters (*Lutra lutra*) with ketamine hydrochloride]. Dtsch. Tierarztl. Wochenschr. 91: 66-68.
Reynolds, P. E., and G. W. Garner. 1983. Immobilizing and marking muskoxen in the Arctic National Wildlife Refuge, Alaska. Proc. Alaska Sci. Conf. 34: 71.
Reynolds, W. T. 1983. Unusual anaesthetic complication in a pelican. Vet. Rec. 113: 204.
Richardson, K. C., and L. K. Cullen. 1981. Anesthesia of small kangaroos. J. Am. Vet. Med. Assoc. 179: 1162-1165.
Reynolds, W. T. 1992. Anaesthesia of a bottle nose dolphin (*Tursiops truncatus*). J. Vet. Anaesth. 19.
Richardson, P. R. K., and M. D. Anderson. 1993. Chemical capture of the aardwolf *Proteles cristatus*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 244-246.
Richardson, K. C., and L. K. Cullen. 1984. Physical and chemical restraint of small macropods. Int. Zoo Yb. 23: 215-218.
Richardson, P. R. K. 1983. An improved darting system for immobilizing smaller mammals in the wild. So. Afr. J. Wildl. Res. 13: 51-54.
Richter, A. G. 1977. Ketamine-xylazine immobilization of a mule deer. J. Am. Vet. Med. Assoc. 171: 987.
Richter, N. A. 1983. Lyophilization of ketamine hydrochloride to increase concentration. Proc. Am. Assoc. Zoo Vet. P. 4.
Ridgway, S. H., and J. G. McCormick. 1967. Anesthesia for major surgery in porpoises. Science 158: 510-512.
Ridgway, S. H., and J. G. Simpson. 1969. Anesthesia and restraint for the California sea lion. J. Am. Vet. Med. Assoc. 155: 1059-1063.
Ridgway, S. H., and J. G. McCormick. 1971. Anesthesia of the porpoise. *In* Soma, L. (ed.). Veterinary Anesthesia. Williams and Wilkins Co., Baltimore, Maryland. Pp. 394-402.
Ridgway, S. H., R. F. Green, and J. C. Sweeney. 1975. Mandibular anesthesia and tooth extraction in bottlenosed dolphin. J. Wildl. Dis. 11: 415-418.
Rie, I. P. 1973. Application of drugs to the skin of salamanders. Herpetologica. 29: 55-59.
Riebold, T. W., A. J. Kaneps, and W. B. Schmotzer. 1986. Reversal of xylazine-induced sedation in llamas, using doxapram or 4-aminopyridine and yohimbine. J. Am. Vet. Med. Assoc. 189: 1059-1061.
Riebold, T. W., W. B. Schmoltzer, and M. J. Huber. 1992a. Anaesthetic techniques

in the llama. *In* Hall, L. W., J. S. M. M. van Dieten, P. van Dijk, L. J. Hellebrekers, and E. Lagerweij. (eds.). Proceedings of the 4th International Congress of Veterinary Anaesthesia. R & W Publications, Newmarket. Pp. 237-240.

Riebold, T. W., M. J. Huber, and W. B. Schmoltzer. 1992b. Monitoring techniques and supportive therapy in the anaesthetized llama. *In* Hall, L. W., J. S. M. M. van Dieten, P. van Dijk, L. J. Hellebrekers, and E. Lagerweij. (eds.). Proceedings of the 4th International Congress of Veterinary Anaesthesia. R & W Publications, Newmarket. Pp. 241-242.

Rietjkerk, F. E., E. C. Delima, and S. M. Mubarak. 1994. The hematological profile of the mountain gazelle (*Gazella gazella*): variations with sex, age, capture method, season and anesthesia. J. Wildl. Dis. 30: 69-76.

Rieu, M., and B. Gautheron. 1968. Preliminary observations concerning a method for introduction of a tube for anesthesia in small delphinids. Lab. d'Acoustique An. Lab. Publ. 78.

Right, J. M. 1983. Ketamine hydrochloride as a chemical restraint for selected small mammals. Wildl. Soc. Bull. 11: 76-79.

Ritchie, B. W., G. J. Harrison, and L. R. Harrison (eds.). 1994. Avian medicine: principles and applications. Wingers, Lake Worth, Florida. 1384 pp.

Robinson, M. E., and S. R. Scadding. 1983. The effect of pH on tricaine methanesulfonate induced anaesthesia of the newt *Notophthalmus viridescens*. Can. J. Zool. 61: 531-533.

Robinson, P. T. 1976. Immobilization of felidae with M99. J. Zoo An. Med. 7: 31.

Robinson, P. T. 1981. A review of thirty-three Queensland koala (*Phascolarctos cinereus adustus*) immobilization procedures. J. Zoo An. Med. 12: 121-123.

Robinson, P. T. 1983. The use of ketamine in restraint of a black-bellied pangolin (*Manis tetradactyla*). J. Zoo An. Med. 14: 19-23.

Robinson, P. T., and C. J. Sedgwick. 1973. Immobilization of a polar bear (*Thalarctos maritimus*) with ketamine HCl. J. Zoo An. Med. 4: 27-28.

Robinson, P. T., and C. J. Sedgwick. 1974. Comment on M99 insert's drug dosage information. J. Zoo An. Med. 6: 7.

Robinson, P. T., and J. Fairfield. 1974. Immobilization of an ostrich with ketamine HCl. J. Zoo An. Med. 5: 11.

Robinson, P. T., and D. Lambert. 1986. A review of 226 chemical restraint procedures in great apes at the San Diego Zoo. Proc. Am. Assoc. Zoo Vet. P. 183.

Rogers, L. L. 1970. An analysis of succinylcholine chloride immobilization of black bears. M.S. Thesis, University of Minnesota. 59 pp.

Rogers, L. L., C. M. Stowe, and A. W. Erickson. 1976. Succinylcholine chloride immobilization of black bears. *In* Pelton, M. R., J. W. Lentfer, and G. E. Folk Jr. (eds.). Bears - Their Biology and Management. IUCN Publ. New Ser. 40. Pp. 431-446.

Rogers, P. S. 1992. The immobilization of lions and leopards with Zoletil®. *In* Ebedes, H. (ed.) The Use of Tranquillizers in Wildlife. Dept. Ag. Develop., Pretoria. Bull. No. 423. Pp. 66-67.

Rogers, P. S. 1993a. The capture of large carnivores using orally administered

drugs. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 251-254.

Rogers, P. S. 1993b. Chemical capture of the white rhinoceros *Ceratotherium simum*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 512-528.

Rogers, P. S. 1993c. Chemical capture of the black rhinoceros *Diceros bicornis*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 553-555.

Rohr, F., and A. A. McKenzie. 1993. Remote injection equipment. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 116-130.

Röken, B. O. 1975. Chemical restraint and anaesthesia in African herbivores. Sonderdruck aus Verhandloungbericht des XVII Internationalen Symposiums uber die Erkrankungen der Zootiere Tunis. Berlin, Akademie-Verlag. Pp. 135-153.

Röken, B. O. 1985. Some medical observations on immobilizing free-ranging moose in Sweden. Proc. V Int. Conf. Wildl. Dis., Uppsala. Pp. 59.

Röken, B. O. 1987. Medetomidine in zoo animal anaesthesia. Proc. 1st Int. Conf. Zool. Avian Med. 1: 535-538.

Röken, B. O. 1975. Chemical restraints and anesthesia in African herbivores. *In* Sonderdruck aus Verhandlungsbericht des XVII Internationalen Symposiums uber die Erkrankungen der Zootiere. Berlin, Akademie-Verlag. Pp. 135-153.

Rolfe, J. D., and J. C. Haigh. 1985. Yohimbine and physostigmine reversal of xylazine plus ketamine immobilizations in sheep, dogs and wapiti. Proc. Am. Assoc. Zoo Vet. Pp. 128-132.

Roney, E. E. 1971. Use of the blowgun to immobilize or medicate caged animals. J. Zoo An. Med. 2: 25.

Rosatte, R. C., and D. P. Hobson. 1983. Ketamine hydrochloride as an immobilizing agent for striped skunks. Can. Vet. J. 24: 134-135.

Rosborough, J. P., E. M. Bailey, L. A. Geddes, and W. A. Tacker. 1974. Experimental anesthetization of a dromedary camel. Zbl. Vet. Med. A. 21: 149-156.

Roslyn, J., J. E. Thompson, and L. Denbesten. 1979. Anesthesia for prairie dogs. Lab. An. Sci. 29: 542-544.

Ross, G. J. B., and G. S. Saayman. 1970. A young bull elephant seal immobilized. Afr. Wildl. 24: 331-336.

Ross, R. M., T. W. H. Backman, and R. M. Bennett. 1993. Evaluation of the anesthetic metomidate for the handling and transport of juvenile American shad. Progressive Fish-Culturist 55: 236-243.

Roth, H. H., and B. Montemayor-Taca. 1971. Immobilization of tamaraw (*Anoa midorensis*). Philippine J. Vet. Med. 10: 45-48.

Roughton, R. D. 1975. Xylazine as an immobilizing agent for captive white-tailed deer. J. Am. Vet. Med. Assoc. 167: 574-576.

Roussel, Y. E., and Patenaude. 1975. Some physiological effects of M99 etorphine on immobilized free-ranging moose. J. Wildl. Manage. 39: 634-636.

Roussel, Y. E., and C. Pichette. 1974. Comparison of techniques used to restrain and mark moose. J. Wildl. Manage. 38: 783-788.

Rowe-Rowe, D. T., and B. Green. 1980. Ketamine and acetylpromazine for black-backed jackal immobilization. So. Afr. J. Wildl. Res. 10: 153.

Rowe-Rowe, D. T., and P. B. Lowry. 1982. A note on the immobilization of serval, *Felis serval* , with ketamine and acetylpromazine. So. Afr. J. Wildl. Res. 12: 109.

Rubright, W. C., and C. B. Thayer. 1970. The use of Innovar-Vet® as a surgical anesthetic for the guinea pig. Lab. An. Care 20: 989-991.

Rudge, A. J. B. (ed.). 1983. The Capture and Handling of Deer. Nature Conservancy Council, Peterborough, United Kingdom. 135 pp.

Rudge, M. R., and R. J. Joblin. 1976. Comparison of some methods of capturing and marking feral goats (*Capra hircus*). N. Z. J. Zool. 3: 51-55.

Rüedi, D., and J. Voellm. 1976. The blow gun - an anesthetizing instrument for the immobilization of wild animals. Vet. Med. Rev. 1: 85-90.

Rüedi, D., and J. Voellm. 1977. The use of the blow-pipe in the Basel Zoological Garden. Proc. Am. Assoc. Zoo Vet. Pp. 1-6

Ryding, F. N. 1982. Ketamine immobilization of southern elephant seals by a remote injection method. Br. Antarct. Survey Bull. 57: 21-26.

Sagner, G., and G. Haas. 1969. Bayer Va 1470 for the anesthesia and sedation of domestic and wild animals. 11th Int. Symp. Dis. Zoo and Wild An., Zagreb. Berlin, Akademie-Verlag Pp. 131-133.

Saint John, B. E. 1992. Pulse oximetry: theory, technology, and clinical considerations. Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. Pp. 223-229.

Sale, J. B., V. Rishi, K. N. Singh, and V. K. Verma. 1986. Drug immobilization of the Indian elephant. J. Bombay Nat. Hist. Soc. 83: 49-56.

Salonen, J. S. 1989. Pharmacokinetics of medetomidine. Acta Vet. Scand. Suppl. 85: 49-54.

Samour, J. H., D. M. Jones, J. A. Knight, and J. C. Howlett. 1984. Comparative studies of the use of some injectable anaesthetic agents in birds. Vet. Rec. 115: 6-11.

Samour, J. H., J. Irwin-Davies, and E. Faraj. 1990. Chemical immobilisation in ostriches (*Struthio camelus*) using etorphine hydrochloride. Vet. Rec. 127: 575-576.

Samuelson, J. 1983. Trapping methods for big game. N. D. Outdoors. 45: 20-21.

Sancken, U., and K. Fischer. 1988. [Biotelemetrically established daily profile of the core body temperature of the female fallow deer (*Dama dama* L.) following immobilization with the Hellabrunner mixture in various environmental temperatures]. Deutsche Tierärztliche Wochenschrift 95: 16-19.

Sandegren, F., L. Pettersson, P. Ahlqvist, and B. O. Röken. 1987. Immobilization of moose in Sweden. Swed. Wildl. Res. Viltrevy. 1: 785-791.

Sandelien, H. 1966. Oral administration of Valium® to restless and aggressive

mink. Nord. Vet. Med. 18: 271-276.
Sarno, R. J., R. L. Hunter, and W. L. Franklin. 1996. Immobilization of guanacos by use of tiletamine/zolazepam. J. Am. Vet. Med. Assoc. 208: 408-409.
Sauer, B. W., H. A. Gorman, and R. J. Boyd. 1969. A new technique for restraining mule deer. J. Am. Vet. Med. Assoc. 155: 1080-1084.
Savage, B. 1985. Giraffe restraint. Proc. Am. Assoc. Zool. Parks Aquaria. Pp. 48-50.
Savarie, P. J. 1976. Pharmacological review of chemicals used for the capture of animals. Proc. Vertebrate Pest Control Conf. 7: 178-184.
Scanlon, J. J., and M. R. Vaughan. 1985. Relationship between injection point of succinylcholine chloride and time to immobilization for white-tailed deer. Trans. Northeast Sect. Wildl. Soc. 42: 219.
Scanlon, P. F. 1973. Observations on the immobilization of fallow deer with powdered succinylcholine chloride injected by dart. Vet. Rec. 93: 396-398.
Scanlon, P. F., and P. Brunjak. 1984. Drug immobilization methods. *In* Halls, L. K. (ed). White-tailed Deer Ecology and Management. Stackpole, Harrisburg, Pa. Pp. 677-686.
Scanlon, P. F., and R. E. Mirarchi. 1974. Variation in reaction of white-tailed deer to immobilization attempts using darts containing succinylcholine chloride. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 27: 296.
Scanlon, P. F., R. E. Mirarchi, and J. A. Wesson. 1977. Aggression toward immobilized white-tailed deer by other deer and elk. Wildl. Soc. Bull. 5: 193-194.
Schafer, E. W., and D. J. Cunningham. 1972. An evaluation of 148 compounds as avian immobilizing agents. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. No. 150. 30 pp.
Schafer, E. W., R. I. Starr, D. J. Cunningham, and T. J. DeCino. 1967. Substituted phenyl N-methylcarbamates as temporary immobilizing agents for birds. J. Agr. Food Chem. 15: 287-289.
Schaller, G. B., J. Hu, W. Pan, and J. Zhu. 1985. The Giant Pandas of Wolong. U. Chicago Press, Chicago, Illinois. Pp. 109-100.
Scheepers, J. L., and K. A. E. Venzke. 1993. The use of a laser sight for the nocturnal immobilization of free-ranging lions. Madoqua 18: 181-182.
Schels, H. F., and I. Nowrouzian. 1977. The effects of reversible narcotic immobilisation in the Iranian camel. Vet. Rec. 101: 388.
Schiappacasse Faundes, M. P. 1991. Characterization and evaluation of the sedation, immobilization and anesthesia with xylazine-ketamine, of vicunas (*Vicugna vicugna*) in captivity. Avances en Ciencias Veterinarias 6: 76-77 (abstract of thesis, Universidad de Chile).
Schildger, B. J., R. Baumgartner, W. Hafeli, A. Rubel, and E. Isenbugel. 1993. Anaesthesia and immobilization of reptiles. Tierarztliche Praxis 21: 361-376.
Schmidl, J. A. 1974. Experimental use of Rompun in the exotic species. J. Zoo An. Med. 5: 8-10.
Schmidt, M. J. 1975a. A preliminary report on the use of Rompun in captive Asian elephants. J. Zoo An. Med. 6: 13-21.
Schmidt, M. J. 1975b. The use of xylazine in captive Asian elephants. Proc. Am.

Assoc. Zoo Vet. Pp. 1-11.

Schmidt, M. J. 1983. Antagonism of xylazine sedation by yohimbine and 4-aminopyridine in an adult Asian elephant (*Elephas maximus*). J. Zoo An. Med. 14: 94-97.

Schmitt, S. M., and R. W. Aho. 1988. Reintroduction of moose from Ontario to Michigan. *In* Nielsen, L., and R. D. Brown (eds.). Translocation of Wild Animals. Wisconsin Humane Society, Inc., and Cesar Kleberg Wildlife Research Institute, Milwaukee, Wisconsin. Pp. 258-274.

Schmitt, S. M., and W. J. Dalton. 1987. Immobilization of moose by carfentanil and xylazine and reversal by naltrexone, a long-acting antagonist. Alces. 23: 195-219.

Schobert, E. 1987. Telazol® use in wild and exotic animals. Vet. Med. Sm. An. Clin. Pp. 1080-1088.

Schultze, H., J. Werner, and H. Breustedt. 1976. Unsatisfactory results with xylazine (Rompun) for the immobilization of a roe deer. Praktische Tierarzt. 57: 833-835.

Schulz, G., and W. Dingeldein. 1980. [Experiences in sedation and immobilisation of fenced fallow deer]. Z. Jagdwiss. 26: 153-158.

Schulz, T. A., and M. E. Fowler. 1974. The clinical effects of CI 744 in chinchillas, *Chinchilla villidera* (Laniger). Lab. An.Sci. 24: 810-812.

Schulz, T. A., and S. Silverman. 1973. Chemical restraint of two slow Lorises (*Nycticebus coucang*) with Vetalar (ketamine). J. Zoo An. Med. 4: 27-28.

Schumacher, J., H. B. Lillywhite, W. Norman, and E. R. Jacobson. 1992. The effects of ketamine on cardiopulmonary function in snakes. Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. P. 173.

Schumacher, J., D. J. Heard, R. Caligiuri, T. Norton, and E. R. Jacobson. 1996. Comparative effects of etorphine and carfentanil on cardiopulmonary parameters in juvenile elephants (*Loxodonta africana*). J. Zoo Wildl. Med. 26: 503-507.

Schumacher, J., D. J. Heard, and L. Young. 1995. Cardiopulmonary effects of carfentanil in dama gazelles (*Gazella dama*). Proc. Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 296.

Schwab, F. E., S. W. Schwab, and M. D. Pitt. 1984. Moose immobilization program in Northcentral British Columbia. Alces. 20: 209-221.

Schwartz, C. C., K. J. Hundertmark, and W. R. Lance. 1991. Effects of R51163 on intake and metabolism in moose. J. Wildl. Dis. 27: 119-122.

Schweinsburg, R. E., L. J. Lee, and J. C. Haigh. 1982. Capturing and handling polar bears. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 267-288.

Scott, H., and R. J. Kolata. 1982. Anesthesia for the North American opossum (*Didelphis virginiana*). Lab. An. Sci. 32: 433.

Seal, U. S. 1987. Phencyclidine immobilization of wild grizzly bears (*Ursus arctos*): analysis of possible persistent effects. Int. Conf. Bear Res. and Manage. 6.

Seal, U. S., and A. W. Erickson. 1969. Immobilization of carnivora and other mammals with phencyclidine and promazine. Fed. Proc. 28: 1410-1419.

Seal, U. S., and R. L. Hoskinson. 1978. Metabolic indicators of habitat condition and capture stress in pronghorns. J. Wildl. Manage. 42: 755-763.

Seal, U. S., and M. Bush. 1987. Capture and chemical immobilization of cervids. *In* Wemmer, C. M. (ed.). Biology and Management of the Cervidae. Smithsonian Institution Press, Washington D.C. Pp. 480-504.

Seal, U. S., and T. J. Kreeger. 1987. Chemical immobilization of furbearers. *In* Novak, M., J. A. Baker, M. E. Obbard, and B. Malloch (eds.). Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto. Pp. 191-215.

Seal, U. S., A. W. Erickson, and J. G. Mayo. 1970a. Drug immobilization of the Carnivora. Int. Zoo Yb. 10: 157-170.

Seal, U. S., J. Anderson, R. Farnsworth, and J. Fletcher. 1970b. Airborne transport of an uncaged, immobilized 260 kg (572 lb) lowland gorilla. Intl. Zoo Yb. 10: 134.

Seal, U. S., J. J. Ozoga, A. W. Erickson, and L. F. Verme. 1972. Effects of immobilization on blood analyses of white-tailed deer. J. Wildl. Manage. 36: 1034-1040.

Seal, U. S., D. B. Siniff, J. R. Tester, and T. D. Williams. 1985a. Chemical immobilization and blood analysis of feral horses (*Equus caballus*). J. Wildl. Dis. 21: 411-416.

Seal, U. S., S. M. Schmitt, and R. O. Peterson. 1985b. Carfentanil and xylazine for immobilization of moose (*Alces alces*) on Isle Royale. J. Wildl. Dis. 21: 48-51.

Seal, U. S., D. L. Armstrong, and L. G. Simmons. 1987. Yohimbine hydrochloride and xylazine hydrochloride immobilization of Bengal tigers and effects of hematology and serum chemistries. J. Wildl. Dis. 23: 296-300.

Sedgwick, C. J. 1979. Field anesthesia in stressed animals. Mod. Vet. Pract. 60: 531-537.

Sedgwick, C. J. 1980a. Issues in zoo animal anesthesia. Proc. Am. Assoc. Zoo Vet. Pp. 12-15.

Sedgwick, C. J. 1980b. Anesthesia of reptiles. *In* Kirk, R. W. (ed.). Current Veterinary Therapy VII. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 618-620.

Sedgwick, C. J. 1986a. Chemical immobilization of wildlife. Seminars Vet. Med. Surg. (Small Anim.). 1: 215-223.

Sedgwick, C. J. 1986b. Inhalation anesthesia for captive wild mammals, birds, and reptiles. *In* Fowler, M. E. (ed.). Zoo and Animal Medicine (2nd ed.). W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 52-56.

Sedgwick, C. J. 1991. Allometrically scaling the data base for vital sign assessment used in general anesthesia of zoological species. Proc. Am. Assoc. Zoo Vet. Pp. 360-369.

Sedgwick, C. J., and A. L. Acosta. 1969. Capture drugs. Mod. Vet. Pract. 12: 32-36.

Sedgwick, C. J., and J. C. Martin. 1994. Concepts of veterinary practice in wild mammals. Vet. Clin. No. Am. Sm. An. Pract. 24: 175-185.

Seidel, B. 1971. Erfahrungen mit Rompun (BAY Va 1470) bei Immobilisation und Anesthesia von Wildtieren. Verhandlungbericht des XIII. Proc. Int. Symp. Erkrankungen Zootiere, Helsinki, Finland. Pp. 219-225.

Seidel, B. 1979. Tierärztliche Gesichtspunkte der Gefangenschaftshaltung von Moschusochsen (*Ovibos moschatus*). Zool. Garten N. F. Jena 49: 131-160.

Seidel, B., and G. Strauss. 1984. [Observation on the clinical anesthesiology of cervidae]. Zool. Gart. 54: 49-100.

Seidensticker, J., M. G. Hornocker, R. R. Knight, and S. L. Judd. 1970. Techniques and equipment for radiotracking mountain lions and elk. Univ. Idaho For. Wildl. Range Exp. Sta. Bull. No. 6: 1-20.

Seidensticker, J., K. M. Tamang, and C. W. Gray. 1974. The use of CI-744 to immobilize free-ranging tigers and leopards. J. Zoo An. Med. 5: 22-25.

Sepúlveda, M. S., H. Ochoa-Acuña, and G. S. McLaughlin. 1994. Immobilization of Juan Fernandez fur seals, *Arctocephalus philippii*, with ketamine hydrochloride and diazepam. J. Wildl. Dis. 30: 536-540.

Servin, J., C. Huxley, and M. Vences. 1990. The combined use of ketamine hydrochloride and xylazine hydrochloride for immobilization of the wild coyote *Canis latrans*. Acta Zoologica Mexicana 36: 27-37.

Servin, J., and C. Huxley. 1992. Immobilization of wild carnivores with a mixture of ketamine and xylazine. Veterinaria Mexico 23: 135-139.

Severinghaus, C. W. 1950. Anesthetization of white-tailed deer. Cornell Vet. 40: 275-282.

Shafer, E. W., and D. J. Cunningham. 1972. An evaluation of 146 compounds as avian immobilizing agents. U. S. Dept. Interior Bur. Sport Fish. Wildl. Spec. Sci. Rep. 150: 1-21.

Shashidhar, M. K. 1981. Translocation of four horned antelope *Tetrecerus quadricornis* using ketamine anaesthesia. Tigerpaper. 8: 8.

Shaughnessy, P. D. 1991. Immobilisation of crabeater seals, *Lobodon carcinophagus*, with ketamine and diazepam. Wildl. Res. 18: 165-168.

Shima, A., H. McCracken, R. Booth, and M. J. Lynch. 1993. Use of tiletamine-zolazepam in the immobilization of marsupials. Proc. Am. Assoc. Zoo Vet. Pp. 171-174.

Shmidl, J. A. 1974. Experimental use of rompun in the exotic species. J. Zoo An. Med. 5: 8-11.

Short, C. E. 1969. Anesthesia, sedation and chemical restraint in wild and domestic animals. J. Wildl. Dis. 5: 307-310.

Short, C. E., and J. M. King. 1963. The design of a crossbow for immobilization of wild animals. Vet. Rec. 76: 628-630.

Short, R. V. 1963. A syringe projectile for use with a bow and arrow. Vet. Rec. 75: 883-885.

Short, R. V., and J. M. King. 1964. The design of a crossbow and dart for the immobilization of wild animals. Vet. Rec. 76: 628-630.

Short, R. V., and C. A. Spinage. 1967. Drug immobilization of the Defassa water-

buck. Vet. Rec. 81: 336-340.

Shrestha, M. N., and S. Shrestha. 1981/1982. The use of xylazine and ketamine hydrochloride in combination in zoo animals. Bull. Vet. Sci. An Health, Nepal 10/11: 24-27.

Shryer, J. 1971. A new device for remote injection of liquid drugs. J. Wildl. Manage. 35: 180-181.

Siemon, A., H. Wiesner, and G. Von Hegel. 1992. Combination of tiletamine, zolazepam and romifidine for remote immobilization of wild pigs. Tierarztliche Praxis 20: 55-58.

Siglin, R. J. 1965. Movements and capture techniques. A literature review of mule deer. Colorado Dept. Game Fish Parks and Colorado Coop. Wildl. Res. Unit Spec. Rpt. No. 4. 39 pp.

Siemon, A. 1991. Pulse and respiration measurements in zoo and wild animals anaesthetized with ketamine and xylazine or with etorphine, acepromazine and xylazine, and the effect of narcotic antagonists. Inaugural Dissertation, Tierarztliche Fakultat, Ludwig-Maxmilians-Universitat, Munchen, Germany, 189 pp.

Sikarskie, J. G., T. Riebold, and J. Stick. 1981. Management of esophagotomy in an Asian elephant. Proc. Am. Assoc. Zoo Vet. Pp. 106-108.

Silberman, M. S. 1974. Restraint and handling of carnivores. Proc. Am. Assoc. Zoo Vet. P. 193.

Silberman, M. S. 1977. Tranquilization of the African Elephant (*Loxodonta africana*, Blumenbach) with the neuroleptic azaperone (R 1929). J. Zoo An. Med. 8: 7-8.

Silberman, M. S. 1982. Emergency medicine during drug immobilization. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 72-82.

Silberman, M. S., and L. J. McWilliams. 1972. Notes on practical applications of Cap-Chur equipment in large animal medicine. Part I. Ga. Vet. 24: 14-15.

Sillero-Zubiri, C. 1996. Field immobilization of Ethiopian wolves (*Canis simensis*). J. Wildl. Dis. 32: 147-151.

Silva, I. D., and V. Y. Kuruwita. 1993. Hematology, plasma, and serum biochemistry values in free-ranging elephants (*Elephas maximus ceylonicus*) in Sri Lanka. J. Zoo Wildl. Med. 24: 434-439.

Silvestris, R., and H. Heck. 1984. Further experiments for immobilization at the Catskill Game Farm. Zool. Gart. 54: 46-48.

Simpson, A. M., J. M. Suttie, G. A. M. Sharman, and W. Corrigal. 1983. Influence of some sedative drugs on the appetite of red deer. Vet. Rec. 112: 385.

Singh, A. N., and A. Singh. 1982. Vetalar and Rompun, an ideal combination of immobilizing drugs for subhuman primates and ungulates. Indian For. 108: 676-677.

Singh, A. N., and A. Singh. 1985. Ketamine hydrochloride - an ideal chemical restraint for leopards. Tigerpaper. 12: 16-18.

Singh, R., P. K. Peshin, D. B. Patil, R. Sharda, J. Singh, A. P. Singh, and D. Sharifi.

1994. Evaluation of halothane as an anaesthetic to camels (*Camelus dromedarius*). J. Vet. Med. (India). 41: 359-368.

Sinha, S. K. 1976. Drug immobilization trials on free-living Indian wild animals. Cheetal. 17: 29-54.

Sinnett, E. E., E. A. Wahrenbrock, and G. L. Kooyman. 1981. Cardiovascular depression and thermoregulatory disruption caused by pentothal/ holathane anesthesia in the harbor seal, *Phoca vitulina*. J. Wildl. Dis. 17: 121-130.

Skjonsberg, T., and A. Westhaver. 1978. A study in the chemical immobilization of animals with suggestions for application in Canada's national parks. Unpublished Working Paper. 82 pp.

Slee, F. W., and G. M. Walker. 1977. Immobilising exotic animals. Vet. Rec. 101: 312.

Sleeman, J., and E. Ramsay. 1995. Preliminary investigations in the use of orally administered carfentanil and detomidine to immobilize domestic goats (*Capra hircus*). Proc. Joint Conf. Am. Assoc. Zoo Vet., Wildl. Dis. Assoc., Am. Assoc. Wildl. Vet. East Lansing, Michigan. Pp. 271-272.

Smeller, J. M., M. Bush, and R. W. Custer. 1977. The immobilization of marsupials. J. Zoo An. Med. 8: 16-20.

Smeller, J., and M. Bush. 1976. A physiological study of immobilized cheetahs (*Acinonyx jubatus*). J. Zoo An. Med. 7: 5-7.

Smeller, J., M. Bush, and U. S. Seal. 1976. Observations on immobilization of Pére David's deer. J. Am. Vet. Med. Assoc. 169: 890-893.

Smit, G. L., J. Hattingh, and A. P. Burger. 1979. Haematological assessment of the effects of the anaesthetic MS 222 in natural and neutralized form in three freshwater fish species; interspecies differences. J. Fish Biol. 15: 633-643.

Smit, G. L., and J. Hattingh. Anaesthetic potency of MS 222 and neutralized MS 222 as studied in three freshwater fish species. Comp. Biochem. Physiol. 62C: 237-241.

Smith, C. A., and A. W. Franzmann. 1979. Productivity and physiology of Yakutat Forelands moose. Alaska Department of Fish and Game. Pittman-Robertson Final Report. W-17-10 and W-17-11. 18 pp.

Smith, C. W., and D. C. Huse. 1980. Tranquilizer dart injury in a dog. J. Am. Vet. Med. Assoc. 176: 140-1.

Smith, I. L., S. W. McJames, R. Natte, T. H. Stanley, J. F. Kimball, T. Becker, B. Hague, and B. Barrus. 1993. A-3080 studies in elk: effective immobilizing doses by syringe and dart injection. Proc. Am. Assoc. Zoo Vet. Pp. 420-421.

Smith, J. L. D., M. W. Sunquist, K. M. Tamang, and P. B. Rai. 1983. A technique for capturing and immobilizing tigers. J. Wildl. Manage.. 47: 255-259.

Smith, L. M., J. W. Hupp, and J. T. Ratti. 1980. Reducing abandonment of nest-trapped gray partridge with methoxyflurane. J. Wildl. Manage. 44: 690-691.

Smith, N. G. 1967. Capturing seabirds with Avertin. J. Wildl. Manage. 31: 479-483.

Smith, R. H., J. Tatsuno, and R. L. Zouhar. 1967. Electroanesthesia: a review - 1966. Anesth. Anal. Curr. Res. 46: 109-125.

Smits, J. E. G., and J. C. Haigh. 1989. Yohimbine hydrochloride administration to

reverse xylazine sedation in white-tailed deer and mule deer. J. Zoo Wildl. Med. 20: 170-172.

Smuts, G. L. 1973a. Xylazine hydrochloride (Rompun) and the new retractable-barbed dart ("drop-out" dart) for the capture of some nervous and aggressive antelope species. Koedoe. 16: 159-173.

Smuts, G. L. 1973b. Ketamine hydrochloride - a useful drug for the field immobilization of the spotted hyaena *Crocuta crocuta*. Koedoe 16: 175-180.

Smuts, G. L. 1975. An appraisal of naloxone hydrochloride as a narcotic antagonist in the capture and release of wild herbivores. J. Am. Vet. Med. Assoc. 167: 559-561.

Smuts, G. L., B. R. Bryden, V. De Vos, and E. Young. 1973. Some practical advantages of CI-581 (ketamine) for the field immobilization of larger wild felines, with comparative notes on baboons and impala. Lammergeyer. 18: 1-14.

Snyder, S. B., M. J. Richard, and W. R. Foster. 1992. Etorphine, ketamine, and xylazine in combination (M99KX) for immobilization of exotic ruminants: a significant additive effect. Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. Pp. 253-263.

Somers, G. F. 1965. Tranquillizers for elephants. "Ours" Magazine. 4: 8-12.

Sowls, L. K., and R. E. Schweinsburg. 1967. An improved propulsion system for short-range projection of immobilization darts. J. Wildl. Manage. 31: 345-346.

Speckmann, G. 1975. Ketaset (ketamine HCI) anesthesia for orchiectomy on a raccon (*Procyon lotor*). J. Zoo An. Med. 6: 31-32.

Spellerberg, I. F. 1969. Capturing and immobilizing McCormick skuas. J. Am. Vet. Med. Assoc. 155: 1040-1043.

Spelman, L. H., P. W. Sumner, J. F. Levine, and M. K. Stoskopf. 1993a. Field anesthesia in the North American river otter (*Lutra canadensis*). J. Zoo Wildl. Med. 24: 19-27.

Spelman, L. H., M. K. Stoskopf, J. F. Levine, and P. W. Sumner. 1993b. Immobilization of North American river otters (*Lutra canadensis*) with medetomidine-ketamine and reversal by atipamezole. Proc. Am. Assoc. Zoo Vet. Pp. 142-143.

Spelman, L. H., P. W. Sumner, J. F. Levine, and M. K. Stoskopf. 1994. Anesthesia of North American river otters (*Lutra canadensis*) with medetomidine-ketamine and reversal by atipamezole. J. Zoo Wildl. Med. 25: 214-223.

Spiegel, R. A., R. E. Larsen, T. J. Lane, and P. T. Cardeilhac. 1984a. Chemical restraint in the American alligator (*Alligator mississippiensis*) using a combination of diazepam and succinylcholine chloride. Proc. Int. Assoc. Aquat. Anim. Med. 1: 13-16.

Spiegel, R. A., T. J. Lane, R. E. Larsen, and P. T. Cardeilhac. 1984b. Diazepam and succinylcholine chloride for restraint of the American alligator. J. Am. Vet. Med. Assoc. 185: 1335-1336.

Spraker, T. R. 1977. Capture myopathy of Rocky Mountain bighorn sheep. Desert Bighorn Council Trans. 21: 14-16.

Spraker, T. R. 1982. An overview of the pathophysiology of capture myopathy and

related conditions that occur at the time of capture of wild animals. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 83-118.

Spraker, T. R. 1986. Capture techniques in feral ruminants. Vet. Clin. North Am. [Food Anim. Pract.]. 2: 693-710.

Spraker, T. R. 1993. Stress and capture myopathy in artiodactylids. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 481-488.

Spurlock, G. H., and S. L. Spurlock. 1988. Projectile dart foreign body in a horse. J. Am. Vet. Med. Assoc. 193: 565.

Stafford, S. K., and L. E. Williams Jr. 1968. Data on capturing black bears with alpha-chloralose. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm.

Stander, P. E., and P. V. B. Morkel. 1991. Field immobilization of lions using dissociative anaesthetics in combination with sedatives. Afr. J. Ecol. 29: 137-148.

Stander, P. E., and W. C. Gasaway. 1991. Spotted hyenas immobilized with ketamine/xylazine and antagonized with tolazoline. Afr. J. Ecol. 29: 168-169.

Stanley, T. H., J. D. Port, J. Kimball, J. E. Oosterhuis, and D. L. Janssen. 1984. New drugs for immobilization of non-domestic hoofstock. Proc. Am. Assoc. Zoo Vet. P. 56.

Stanley, T. H., J. D. Port, J. Van der Maaten, and J. Kimball. 1986. Treatment of stress hyperthermia in elk with ketanserin, a serotonin receptor blocker. Vet. Surg. 15: 214-217.

Stanley, T. H., S. McJames, J. Kimball, J. D. Port, and N. L. Pace. 1988. Immobilization of elk with A-3080. J. Wildl. Manage. 52: 577-581.

Stanley, T. H., S. McJames, and J. Kimball. 1989. Chemical immobilization for the capture and transportation of big game. Proc. Am. Assoc. Zoo Vet. Pp. 13-14.

Stanley, T. H., J. D. Port, N. L. Pace, J. Kimball, and S. McJames. 1988. Chemical immobilization using new high potency opioids and other drugs and drug combinations with high therapeutic indices. U. S. Dept. Defense Chemical Research Development & Engineering Center, CRDEC-CR-88077. 122 pp.

Starke, R. 1991. Observations on the use of xylazine in combination with other agents for the immobilization of wapiti. *In* Renecker, L.A., and R. J. Hudson (eds.). Wildlife Production: Conservation and Sustainable Development. University of Alaska, Fairbanks.

Stelfox, J. G., and J. R. Robertson. 1976. Immobilizing bighorn sheep with succinylcholine chloride and phencyclidine hydrochloride. J. Wildl. Manage. 40: 174-176.

Stemmler, O., and A. Zingg. 1969. Das Betäuben von Schlangen (The anesthetizing of snakes). Der Zool. Gart. 37: 76-80.

Stewart, G. R., J. M. Siperek, and V. R. Wheeler. 1980. Use of the cataleptoid anesthetic CI-744 for chemical restraint of black bears. Int. Conf. Bear Res. Manage. 4: 57-61.

Steyn, D. G. 1975. The effect of phencyclidine anaesthesia on the blood chemistry and haematology of the chacma baboon (*Papio ursinus*). J. So. Afr. Vet. Assoc. 46: 235-239.

Still, J. 1993. Etorphine-azaperone anaesthesia in an African elephant (*Loxodonta africana*). J. Vet. Anaesth. 20: 54-55.

Stirling, I., and B. Sjare. 1988. Preliminary observations on the immobilization of male Atlantic walruses (*Odobenus rosmarus rosmarus*) with Telazol. Mar. Mammal Sci. 4: 163-168.

Stirling, I., E. Broughton, L. Ø. Knutsen, M. A. Ramsay, and D. S. Andriashek. 1985. Immobilization of polar bears with Telazol® on the western coast of Hudson Bay during summer, 1984. Can. Wildl. Serv. Prog. Notes. 157: 1-7.

Stirling, I., C. Spencer, and D. S. Andriashek. 1989. Immobilization of polar bears (*Ursus maritimus*) with Telazol® in the Canadian Arctic. J. Wildl. Dis. 25: 159-168.

Stoskopf, M. K. 1979. Anesthesia of zoo rodents. Proc. Am. Assoc. Zoo Vet. Pp. 68-69.

Stoskopf, M. K. 1986. Immobilization of captive sharks. Proc. Am. Assoc. Zoo Vet. Pp. 106-108.

Stoskopf, M. K. 1993. Shark pharmacology and toxicology. *In* Stoskopf, M. K. (ed.). Fish Medicine. Saunders, Philadelphia. Pp. 809-816.

Stoskopf, M. K., and L. Bishop. 1978. Immobilization of two captive adult Nile hippo (*Hippopotamus amphibius*). J. Zoo An. Med. 9: 103-107.

Stoskopf, M. K., F. B. Beall, P. K. Ensley, and E. Neely. 1982. Immobilization of large ratites: blue necked ostrich (*Struthio camelus austrealis*) and double wattled cassowary (*Casuarius casuarius*) — with hematologic and serum chemistry data. J. Zoo An. Med. 13: 160-168.

Strauss, G. 1987. Zum Einsatz von Tolazolin bei der Xylazin/Ketamin Immobilisation. 29th Int. Symp. Dis. Zoo and Wild An. Pp 151-155.

Strauss, G. 1992. Erfahrungen bei der Immobilisation verschneidener Equidenarten im Tierpark Berlin-Friedrichsfelde. Erkr Zootiere 34: 163-169.

Strond, W. L., and S. D. Baxter. 1980. The use of ketaset (ketamine hydrochloride) as a rapid acting anesthetic agent in two species of sympatric rattlesnakes. Proc. Neb. Acad. Sci. Affil. Soc. 90: 21.

Stullken, D. E., and C. M. Kirkpatrick. 1955. Physiological investigation of captivity mortality in the sea otter (*Enhydra lutris*). Trans. No. Am. Wildl. Conf. 20: 476-494.

Stunkard, J. A., and J. C. Miller. 1974. An outline guide to general anesthesia in exotic species. Vet. Med. Sm. An. Clin. 69: 1181-1186.

Summerhays, G. 1976. Overdosage with nalorphine hydrobromide following self-inflicted injury with Immobilon. Vet. Rec. 99: 36.

Sutherland, C., and J. Hodgkin. 1974. Tranquilizing deer. Vet. Rec. 95: 71.

Swan, G. E. 1993. Drugs used for the immobilization, capture, and translocation of wild animals. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 2-64.

Sylvester, J. R. 1975. Factors influencing the efficacy of MS-222 to striped mullet (*Mugil cephalus*). Aquaculture 6: 163-169.

Szabuniewicz, M., L. Sanches, A. Sosa, And M. De Gomez. 1978. Sedatión y anestesia del chiguire (*Hydrochoerus hydrochoeris*, Linné). Revista de la Facultad de Ciencias veterinarias de la Universidad Central de Venezuela 8: 61-78.

Taber, R. D., and I. M. Cowan. 1969. Capturing and marking wild animals. *In* Giles, R. H. (ed.). Wildlife Management Techniques. The Wildlife Society. Washington, D. C. Pp. 277-318.

Talbot, L. M. 1960. Field immobilization of some East African wild animals and cattle. East Afr. Agric. For. J. 26: 92-102.

Talbot, L. M., and H. F. Lamprey. 1961. Immobilization of free-ranging East African ungulates with succinylcholine chloride. J. Wildl. Manage. 25: 303-310.

Talbot, L. M., and M. H. Talbot. 1962. Flaxedil and other drugs in field immobilization and translocation of large mammals in East Africa. J. Mammal. 43: 76-88.

Tamas, P. M., and D. R. Geiser. 1983. Etorphine analgesia supplemented by halothane anesthesia in an adult African elephant. J. Am. Vet. Med. Assoc. 183: 1312-1314.

Taulman, J. F., and J. H. Williamson. 1993. A simple apparatus and technique for anesthetizing raccoons. Am. Mid. Naturalist. 129: 210-214.

Taylor, D. C., and N. Chandler. 1971. Cesarean section in a zebra. Vet. Rec. 89: 388-389.

Taylor, M. 1987. Avian anesthesia - a clinical update. Proc. Int. Conf. Zool. Avian Med. 1: 519-524.

Taylor, M. K., D. P. Demaster, S. P. Sheldon, and R. E. Sorensen. 1982. Use of M50-50 as a therapeutic drug for M99-induced trauma. J. Wildl. Manage. 46: 252-253.

Taylor, R. H., and W. B. Magnussen. 1965. Preliminary note on capture and marking of wild ungulates in New Zealand. N. Z. J. Sci. 8: 205-213.

Taylor, W. P., H. V. Reynolds, and W. B. Ballard. 1989. Immobilization of grizzly bears with tiletamine hydrochloride and zolazepam hydrochloride. J. Wildl. Manage. 53: 978-981.

Teare, J. A. 1987. Antagonism of xylazine hydrochloride-ketamine hydrochloride immobilization in guineafowl (*Numida meleagris*) by yohimbine hydrochloride. J. Wildl. Dis. 23: 301-305.

Teferra, Z. 1992. Chemical immobilisation of wildlife. Walia 14: 9-15.

Terpin, K. M., P. Dodson, and J. R. Spotila. 1978. Observations on ketamine hydrochloride as an anaesthetic for alligators. Copeia. 1978: 147-148.

Thomas, J. W., and R. G. Marburger. 1964. Mortality in deer shot in the thoracic area with the Cap-Chur gun. J. Wildl. Manage. 28: 173-175.

Thomas, J. W., R. M. Robinson, and R. G. Marburger. 1967. Use of diazepam in the capture and handling of cervids. J. Wildl. Manage. 31: 686-692.

Thomas, W. D. 1961. Chemical immobilization of wild animals. J. Am. Vet. Med. Assoc. 138: 263-265.

Thomson, P. C., K. Rose, and N. E. Kok. 1992. Dingoes in northwestern Australia. Wildl. Res. 19: 509-603.

Thorne, E. T. 1971. The use of M-99 etorphine and acetylpromazine in the immobilization and capture of free ranging Rocky Mountain bighorn sheep. Trans. No. Amer. Wild Sheep Conf. 127-134.

Thorne, E. T. 1980. Immobilization of wild ungulates: considerations and drugs. Biotelem. Patient Monitg. 7: 178-187.

Thorne, E. T. 1982. Agents used in North American ruminant immobilization. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 304-334.

Thorne, E. T., M. H. Schroeder, S. C. Forest, T. M. Cambell, L. Richardson, D. Biggins, L. R. Hanebury, D. Belitsky, and E. S. Williams. 1985. Capture, immobilization, and care of black-footed ferrets for research. *In* Anderson, S. H., and D. B. Inkley (eds.). Proceedings of the Black-footed Ferret Workshop. Laramie, Wyoming. Pp. 9.1-9.8.

Throckmorton, G. S. 1981. Ketamine hydrochloride as an anesthetic agent for lizard surgery. Copeia 1981: 241-243.

Thurman, G. D., S. J. T. Downes, and S. Barrow. 1982. Anaesthetization of a cape fur seal (*Arctocephalus pusillus*) for the treatment of a chronic eye infection and amputation of a metatarsal bone. J. So. Afr. Vet. Assoc. 53: 255-257.

Thurmon, J. C., D. R. Nelson, and J. O. Mozier. 1972. A preliminary report on the sedative effect of Bay Va 1470 in elk (*Cervus c. canadensis*). J. Zoo An. Med. 3: 9-14.

Thurmon, J. C., W. J. Tranquilli, and G. J. Benson. 1992. α_2-antagonists: use in domestic and wild animal species. *In* Short, C. E., and A. Van Poznak (eds). Animal Pain. Churchill Livingstone, New York. Pp. 237-247.

Tobey, R. W., and W. B. Ballard. 1985. Increased mortality in gray wolves captured with acepromazine and etorphine hydrochloride in combination. J. Wildl. Dis. 21: 188-190.

Tomkiewicz, S. M. 1982. Advances in capture technology. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 1-17.

Torgerson, R. W. 1990. Polar bear biology and medicine. *In* Dierauf, L. A. (ed.). CRC Handbook of Marine Mammal Medicine: Health, Disease, and Rehabilitation. CRC Press, Boca Raton. Pp. 649-657.

Tranquilli, W. J. 1993a. Injectable anesthesia. Proc. No. Am. Vet. Conf. Orlando, Florida. Pp. 14-15.

Tranquilli, W. J. 1993b. New anesthetic agents. Proc. No. Am. Vet. Conf. Orlando, Florida. Pp. 16-17.

Travaini, A., and M. Delibes. 1994. Immobilization of free-ranging red foxes (*Vulpes vulpes*) with tiletamine hydrochloride and zolazepam. J. Wildl. Dis. 30: 589-591.

Travaini, A., P. Ferreras, M. Delibes, and J. J. Aldama. 1992. Xylazine hydrochloride-ketamine hydrochloride immobilization of free-living red foxes (*Vulpes*

vulpes) in Spain. J. Wildl. Dis. 28: 507-509.

Travaini, A., P. Ferreras, J. J. Aldama, J. M. Fedriani, and M. Delibes. 1994. Chemical immobilization of wild badgers (*Meles meles*). Revue de Médicine Véterinaire 145: 577-580.

Treimo, T. 1971. Immobilisering av isbjorn (*Thalarctos maritimus*). [Immobilization of polar bears (*Thalarctos maritimus*)]. Nor. Vet. Tidsskr. 82: 169-174.

Trembath, P. R. 1985. Restraint of baby elephants with Rompun. Vet. Med. Rev. 2: 169-170.

Trillmich, F. 1983. Ketamine xylazine combination for the immobilization of Galapagos seal lions and fur seals. Vet. Rec. 112: 279-280.

Trillmich, F., and H. Wiesner. 1979. Immobilisation of free-ranging Galapagos sea lions (*Zalophus californianus wollebaeki*). Vet. Rec. 105: 465-466.

Trindle, B. D., and L. D. Lewis. 1978. Methoxyflurane anesthesia in mule deer (*Odocoileus hemionus*) fawns. J. Wildl. Dis. 14: 519-522.

Troyer, W. A., R. J. Hensel, and K. E. Durley. 1961. Live-trapping and handling of brown bears. J. Wildl. Manage. 25: 330-331.

Tsubota, T., K. Yamamoto, T. Mano, M. Yamanaka, and H. Kanagawa. 1991. Immobilization of the free-ranging Hokkaido brown bear, *Ursus arctos yesoensis*, with ketamine hydrochloride and xylazine hydrochloride. J. Vet. Med. Sci. 53: 321-322.

Tung, K. C., J. S. Wang, C. L. Shyu, C. L. Yang, and C. H. Shih. 1993. Studies on the clinical choice and application of chemical immobilization drugs in deer in Taiwan. Taiwan J. Vet. Med. An. Husbandry. 61: 9-18.

Tyler, N. J., R. Hotvedt, A. S. Blix, and D. R. Sørensen. 1990. Immobilization of Norwegian reindeer (*Rangifer tarandus tarandus*) and Svalblad reindeer (*R. t. platyrhynchus*) with medetomidine and medetomidine-ketamine and reversal of immobilization by atipamezole. Acta Vet. Scand. 31: 479-488.

Umbreit, N. 1980. Chemical restraint of reptiles, amphibians, fish, birds, small mammals and selected marine mammals in North America. An annotated bibliography. U. S. Bur. Land Manage. Tech. Note. TN-340. 181 pp.

Vahala, J. 1993. Clinical experience and comparison of ketamine-medetomidine with ketamine-xylazine anesthesia in the African wild dog (*Lycaon pictus*) in captivity. Vet. Med. Czech. 38:569-578.

Valkenburg, P., R. D. Boertje, and J. L. Davis. 1983. Effects of darting and netting caribou in Alaska. J. Wildl. Manage. 47: 1233-1237.

Van Aarde, R. J. 1985. Husbandry and immobilization of captive porcupines *Hystrix africaeaustralis*. So. Afr. J. Wildl. Res. 15: 77-79.

Van Der Eems, K., and R. D. Brown. 1986. Effect of caffeine sodium benzoate, ketamine hydrochloride, and yohimbine hydrochloride on xylazine hydrochloride-induced anorexia in white-tailed deer. J. Wildl. Dis. 22: 403-406.

Van Der Merwe, J. N., D. B. Du Bruyn, W. H. Van Der Walt, and M. R. Sly. 1987. Effects of certain anaesthetics on plasma metabolite concentrations in the baboon (*Papio ursinus*). J. So. Afr. Vet. Assoc. 58: 125-128.

Van Foreest, A. 1980. Use of ketamine/xylazine combination for the tail amputation in nutria (*Myocaster coypus*). J. Zoo An. Med. 11: 19-20.

Van Heerden, J. 1984. Capture and immobilization of the Cape ground squirrel *Xerus inauris* with ketamine hydrochloride. So. Afr. J. Wildl. Res. 14: 127-128.

Van Heerden, J. 1993. Chemical capture of the wild dog *Lycaon pictus*. *In* McKenzie, A. A. (ed.). Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 247-250.

Van Heerden, J., and V. de Vos. 1981. Immobilization of the hunting dog *Lycaon pictus* with ketamine hydrochloride and a fentanyl/ droperidol combination. So. Afr. J. Wildl. Res. 11: 112-113.

Van Heerden, J., and J. Dauth. 1985. Serum potassium and sodium concentrations in dead and hypoxic dogs, shot mountain zebra *Equus zebra zebra*, and chemically immobilized laboratory rats and ground squirrels *Xerus inauris*. So. Afr. J. Wildl. Res. 15: 32-36.

Van Heerden, J. and R. H. Keffen. 1991. A preliminary investigation into the immobilising potential of a tiletamine/zolazepam mixture, metomidate, a metomidate and azaperone combination and medetomidine on ostriches (*Struthio camelus*). J. So. Afr. Vet. Assoc. 62: 114-117.

Van Heerden, J., J. Komen, and E. Myer. 1987. The use of ketamine hydrochloride in the immobilisation of the cape vulture *Gyps coprotheres*. J. So. Afr. Vet. Assoc. 58: 143-144.

Van Heerden, J., G. E. Swan, J. Dauth, R. E. J. Burroughs, and M. J. Dreyer. 1991a. Sedation and immobilization of wild dogs *Lycaon pictus* using medetomidine-ketamine hydrochloride combination. So. Afr. J. Wildl. Res. 21: 88-93.

Van Heerden, J., R. E. J. Burroughs, J. Dauth, and M. J. Dreyer. 1991b. Immobilization of wild dogs (*Lycaon pictus*) with a tiletamine hydrochloride/zolazepam hydrochloride combination and subsequent evaluation of selected blood chemistry parameters. J. Wildl. Dis. 27: 225-229.

Van Jaarsveld, A. S. 1988. The use of Zoletil® for the immobilization of spotted hyaenas. So. Afr. J. Wildl. Res. 18: 65-66.

Van Jaarsveld, A. S., A. A. McKenzie, and D. G. A. Meltzer. 1984. Immobilization and anaesthesia of spotted hyaenas, *Crocuta crocuta*. So. Afr. J. Wildl. Res. 14: 120-122.

Van Mourik, S., and T. Stelmasiak. 1984. The effect of immobilizing drugs on adrenal responsiveness to ACTH in Rusa deer. Comp. Biochem. Physiol. 78: 467-471.

Van Mourik, S., and T. Stelmasiak. 1984. The use of Rompun® for immobilization of mature rusa deer (*Cervus rusa timorensis*) – first report. Vet. Med. Rev. 1984: 163-166.

Van Mourik, S., T. Stelmasiak, and L. Murray 1988. Immobilization of sambar, rusa, red, fallow and chital deer with Fentaz®/Rompun® and reversal with Narcan®/tolazoline. Vet. Med. Rev. 59: 167-170.

Van Niekerk, J. W., and U. De V. Pienaar. 1962. Adaptions of the immobilizing technique to the capture, marking and translocation of game animals in the Kruger National Park. Koedoe 5: 137-143.

Van Niekerk, J. W., and U. De V. Pienaar. 1963a. A report on some immobilizing drugs used in the capture of wild animals in the Kruger National Park. Koedoe 6: 126-133.

Van Niekerk, J. W., and U. De V. Pienaar. 1963b. Adaptation of the immobilizing techniques to the capture, marking and translocation of game animals in the Kruger National Park. Koedoe 5: 137-143.

Van Niekerk, J. W., and U. De V. Pienaar. 1963c. A report on some immobilizing drugs used in the capture of wild animals in the Kruger National Park. Koedoe 6: 126-133.

Van Niekerk, J. W., U. De V. Pienaar, and N. Fairall. 1963a. Immobilizing drugs used in the capture of wild animals in the Kruger Park National. J. So. Afr. Vet. Assoc. 34: 403-411.

Van Niekerk, J. W., U. De V. Pienaar, and N. Fairall. 1963b. A preliminary note on the use of Quiloflex (benzodioxane hydrochloride) in the immobilization of game. Koedoe 6: 109-114.

Van Ouwerkerk, M. T. 1986. Effect of etorphine hydrochloride and xylazine hydrochloride on various physiological parameters of the goat *Capra hircus*. M.S. Thesis, University of Pretoria (South Africa).

Van Reenen, G. 1982. Field experiences in the capture of red deer by helicopter in New Zealand with reference to post-capture sequela and management. *In* Nielsen, L., J. C. Haigh, and M. E. Fowler (eds.). Chemical Immobilization of North American Wildlife. Wisconsin Humane Society, Inc. Milwaukee, Wisconsin. Pp. 408-421.

Van Rensburg, P. J. J. 1993. Chemical capture of the bushpig, *Potamochoerus larvatus*. *In* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria. Pp. 615-616.

Van Rooyen, G. L., and P. J. De Beer. 1973. A retractable barb needle for drug darts. Koedoe 16: 155-158.

Van Wyk, T. C., and H. H. Berry. 1986. Tolazoline as an antagonist in free-living lions immobilised with a ketamine-xylazine combination. J. So. Afr. Vet. Assoc. 57: 221-224.

Varland, K. L. 1976. Techniques for elk immobilization with succinylcholine chloride. Proc. Iowa Acad. 82: 194-197.

Vercruysse, J., and J. Mortelmans. 1978. The chemical restraint of apes and monkeys by means of phencyclidine or ketamine. Acta. Zool. Pathol. Antverpiensia. 70: 211-220.

Vergani, D. F., H. J. Spainrani, and C. A. Aguirre. 1986. Immobilization of crabeater seals, *Lobodon carcinophagus*, with the use of xylazine hydrochloride at 25 De Mayo Island (Antarctica) and identification of polymorphism in transferrins. Contribution No. 317, Direccion Nacional Del Antartico, Instituto Antartico Argentino.

Vertessen, K. 1970. Immobilizatie van everzwijnen door middel van azaperone en fentanyl (Immobilization of wild pigs by means of azaperone and fentanyl). Tijdschr. Diergeneesk. 10: 541-543

Verts, B. J. 1960. A device for anesthetizing skunks. J. Wildl. Manage. 24: 335-336.

Vethamany-Globus, S., M. Globus, and I. Fraser. Effects of tricaine methane sulphonate (M.S. 222) on the blood glucose levels in adult slamanders (*Diemictylus viridescens*). Experientia 33: 1027.

Vice, T. E., L. D. Claborn, and R. A. Ratner. 1965. Anesthetic technics in the baboon with some observations on other primates. *In* Sawyer, D. C. (ed.). Symposium on Experimental Animal Anesthesiology. Brooks Air Force Base, Texas.

Vilà, C., and J. Castroviejo. 1994. Use of tiletamine and zolazepam to immobilize captive Iberian wolves (*Canis lupus*). J. Wildl. Dis. 30: 119-122.

Viljoen, P. C. 1981. Fentanyl citrate for the field immobilization of oribi. So. Afr. J. Wildl. Res. 11: 56-58.

Virtanen, R., and E., MacDonald. 1987. Reversal of the sedative/analgesic and other effects of detomidine and medetomidine by MPV-1248, a novel alpha2-antagonist. Pharmacol. Toxicol. 60 (Suppl. III): 73.

Volkers, J., T. Wensing, and G. W. T. A. Bruinderink. 1994. Sedation of wild boar (*Sus scrofa*) and red deer (*Cervus elaphus*) with medetomidine and the influence on some haematological and serum biochemical variables. Vet. Quart. 16: 7-9.

Volmer, K., and A. Herzog. 1986. [Mineral content of the blood of immobilised red deer of various origins]. Z. Jagdwiss. 32: 22-29.

Vondruska, J. F. 1965. Phencyclidine anesthesia in baboons. J. Am. Vet. Med. Assoc. 147: 1073-1074.

Wallace, R. S., and M. Bush. 1987. Exertional myopathy complicated by a ruptured bladder in a dama gazelle (*Gazella dama*). J. Zoo An. Med. 18: 111-114.

Wallach, G. D., A. R. Fodor, and L. H. Barton. 1960. Restraint of chimpanzees with perphenazine. J. Am. Vet. Med. Assoc. 136: 222-224.

Wallach, J. D. 1966. Immobilization and translocation of the white (Square-lipped) rhinoceros. J. Am. Vet. Med. Assoc. 149: 871-874.

Wallach, J. D. 1968. Wild animal immobilization with the oripavine M-99. Missouri Vet. 19: 12-15.

Wallach, J. D. 1969. Etorphine (M99), a new analgesic immobilizing agent and its antagonists. Vet. Med. Sm. An. Clin. 64: 53-58.

Wallach, J. D. 1977. Anesthesia of reptiles. *In* Kirk, R. W. (ed.). Current Veterinary Therapy VI. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 807-808.

Wallach, J. D., and J. L. Anderson. 1968. Oripavine (M99) combinations and solvents for immobilization of the African elephant. J. Am. Vet. Med. Assoc. 153: 793-797.

Wallach, J. D., and C. Hoessle. 1970. M-99 as an immobilizing agent in poikilothermes. Vet. Med. Sm. An. Clin. 65: 163-167.

Wallach, J. D., R. Frueh, and M. Lentz. 1967. The use of M99 as an immobilizing and analgesic agent in captive wild animals. J. Am. Vet. Med. Assoc. 151: 870-876.

Wallingford, B. D., R. A. Lancia, and E. C. Soutiere. 1996. Antagonism of xylazine

in white-tailed deer with intramuscular injection of yohimbine. J. Wildl. Dis. 32: 399-402.

Walsh, M. T., A. I. Webb, D. O. Beusse, D. A. Brock, S. A. Robertson, N. Abou-Madi, R. A. Cook, and L. Klein. 1988. Sedation and general anesthesia of four arctic walrus (*Odobenus rosmaru*). Abstract, 19th Ann. Intl. Assoc. Aquatic An. Med. Orlando, Florida.

Wang, R., J. L. Kubie, and M. Halpern. 1977. Brevital sodium: an effective anesthetic agent for performing surgery on small reptiles. Copeia 1977: 738-743.

Wang, T., W. Fernandes, and A. S. Abe. 1993. Blood pH and O_2 homeostasis upon CO_2 anesthesia in the rattlesnake (*Crotalus durissus*). Snake 25: 21-26.

Wanzie, C. 1986. Buffon's kob (*Kobus kob kob* Erxleben) immobilisation in Waza National Park, Cameroon. Mammalia. 50: 253-262.

Ward, G. S., D. O. Johnson, and C. R. Roberts. 1974. The use of CI 744 as an anesthetic for laboratory animals. Lab. An. Sci. 24: 737-742.

Warren, R. J., N. L. Schauer, J. T. Jones, P. F. Scanlon, and R. L. Kirkpatrick. 1979. A modified blow-gun syringe for remote injection of captive wildlife. J. Wildl. Dis. 15: 537-541.

Warren, R. J., R. L. Kirkpatrick, D. F. Gibson, and P. F. Scanlon. 1984. Xylazine hydrochloride-induced anorexia in white-tailed deer. J. Wildl. Dis. 20: 66-68.

Wass, J. A., and H. M. Kaplan. 1974. Methoxyflurane anesthesia for *Rana pipiens*. Lab. An. Sci. 24: 669-671.

Watson, C. R. R., and J. S. Way. 1972. The unusual tolerance of marsupials to barbiturate anaesthetics. Int. Zoo Yb. 12: 208-211.

Watson, C. R. R., and J. S. Way. 1973. Anaesthetics for kangaroos. Int. Zoo Yb. 11: 12-13.

Webster, D. M., and V. D. Hollard. 1973. A safe and simple injection anesthetic for birds. Physiol. Behav. 10: 831.

Wedemeyer, G. 1970. Stress of anesthesia with M.S. 222 and benzocaine in rainbow trout (*Salmo gairdneri*). J. Fish. Res. Bd. Canada. 27: 909-914.

Weilenmann, P. 1971. Einige Angaben über die im Zoologischen Garten Zürich und im Wildpark Langenberg verwendeten Sedativa, Tranquilizer und Narkotika. Verhandlungbericht des XIII. Proc. Int. Symp. Erkrankungen Zootiere, Helsinki, Finland. Pp. 207-211.

Weisbroth, S. H., and J. H. Fudens. 1972. Use of ketamine hydrochloride in laboratory rabbits, rats, mice, and guinea pigs. Lab. An. Sci. 22: 904-906.

Wellington, B. J. 1972. Effective sedation and anesthesia of two kangaroos. Austral. Vet. J. 48: 127.

Welsch, D. M. D., E. R. Jacobson, G. V. Kollias, L. Kramer, H. Gardner, and D. Page. 1989. Tusk extraction in the African elephant (*Loxodonta africana*). J. Zoo Wildl. Med. 20: 446-453.

Wentges, H. 1975. Medicine administration by blowpipe. Vet. Rec. 97: 281.

Wesson, J. A., P. F. Scanlon, and R. E. Mirarchi. 1974. Immobilization of white-tailed deer with succinylcholine chloride: success rate, reactions of deer and some physiological effects. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 28: 500-506.

Wesson, J. A., P. F. Scanlon, and R. L. Kirkpatrick. 1976. Increase in progestin and estrone levels in white-tailed deer following drug restraint. Va. J. Sci. 27: 52.

Wesson, J. A., P. F. Scanlon, R. L. Kirkpatrick, and H. S. Mosby. 1977. Influence of immobilizing drugs on blood characteristics of cottontail rabbits. Va. J. Sci. 28: 69.

Wesson, J. A., P. F. Scanlon, R. L. Kirkpatrick, and H. S. Mosby. 1979a. Influence of chemical immobilization and physical restraint on packed cell volume, total protein, glucose, and blood urea nitrogen in blood of white-tailed deer. Can. J. Zool. 57: 756-767.

Wesson, J. A., P. F. Scanlon, R. L. Kirkpatrick, H. S. Mosby, and R. L. Butcher. 1979b. Influence of chemical immobilization and physical restraint on steroid hormone levels in blood of white-tailed deer. Can. J. Zool. 57: 768-776.

Whateley, A. 1979. Selective capture of spotted hyaenas using orally administered sernylan. Lammergeyer. 27: 25-27.

Wheler, C. 1993. Avian anesthesia, analgesics, and tranquilizers. Seminars in Avian Exotic Pet Med. 2: 7-12.

White, G. L., and D. D. Holmes. 1976. A comparison of ketamine and the combination ketamine-xylazine for effective surgical anesthesia in the rabbit. Lab. An. Sci. 26: 804-806.

White, G. L., and J. F. Cummings. 1976. A comparison of ketamine and ketamine-xylazine in the baboon. Vet. Med. Sm. An. Clin. 74: 392-396.

White, P. F., W. L. Way, and A. J. Trevor. 1982. Ketamine – Its pharmacology and therapeutic uses. Anesthesiology. 56: 119-136.

White, P. J., T. J. Kreeger, U. S. Seal, and J. R. Tester. 1990. Pathological responses of red foxes to box traps. J. Wildl. Manage. 55: 75-80.

White, T. H., M. K. Oli, B. D. Leopold, H. A. Jacobson, and J. W. Kasbohm. 1996. Field evaluation of Telazol® and ketamine-xylazine for immobilizing black bears. Wildl. Soc. Bull. 24: 521-527.

White, R. J., P. H. Cribb, G. Glover, and J. Rowell. 1985. Halothane anesthesia in a muskox (*Ovibos moschatus*). J. Zoo An. Med. 16: 58-61.

Wiesner, H. 1975. Zur Neuroleptanalgesie bei Zootieren und Gatterwild unter Anwendung des Telinject-Systems. Kleintier-Praxis 20: 18-24.

Wiesner, H. 1977. Tranquilization by the "blowgun rifle" method. Kleintier-Praxis 22: 327-330.

Wiesner, H. 1993. Chemical immobilization of wild equids. *In* Fowler, M. E. (ed.). Zoo & Wild Animal Medicine: Current Therapy 3. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 475-476.

Wiesner, H., and G. von Hegel. 1985. Praktische Hinweise zur Immobilization von Wild und Zootieren [Practical advice concerning immobilization of wild and zoo animals]. Tierärtzliche Praxis 13: 113-127.

Wiesner, H., and G. Von Hegel. 1989. Zur Immobilisation von Giraffen. Tierärtzliche Praxis 17: 97-100.

Wiesner, H., W. Rietschel, and T. Gatesman. 1982. [Practical experiences with the combination on "Immobilon" and "Rompun" in zoo animals]. Z. Koeln. Zoo. 25: 47-55.

Wiesner, H., W. Rietschel, and T. J. Gatesman. 1984. The use of the morphine-like analgesic carfentanil in captive wild mammals at Tierpark Hellebraun. J. Zoo An. Med. 15: 18-23.

Wiesner, H., and G. Von Hegel. 1990. Zur Immobilisation von Wildequiden mit STH 2130 und Tiletamin/Zolazepam. Tierärtzliche Praxis 18: 151-154.

Williams, D. E., and D. H. Riedesel. 1987. Chemical immobilization of wild ruminants. Iowa State Univ. Vet. 49: 26-32.

Williams, K. D. 1979. Trapping and immobilization of the malayan tapir in West Malaysia. Malay. Nat. J. 33: 117-122.

Williams, L. E. 1966. Capturing wild turkeys with alpha-chloralose. J. Wildl. Manage. 30: 50-56.

Williams, L. E. 1967. Preliminary report on methoxymol to capture turkeys. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 21: 189-193.

Williams, L. E., D. H. Austin, and T. E. Peoples. 1966. Progress in capturing turkeys with drugs applied to baits. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 20: 219-226.

Williams, L. E., and R. W. Phillips. 1972. Tests of oral anesthetics to capture mourning doves and bobwhites. J. Wildl. Manage. 36: 968-971.

Williams, L. E., and R. W. Phillips. 1973. Capturing sandhill cranes with alpha-chloralose. J. Wildl. Manage. 37: 94-97.

Williams, L. E., D. H. Austin, T. E. Peoples, and R. W. Phillips. 1973a. Capturing turkeys with oral drugs. *In* Sanderson, G. C., and H. C. Schultz (eds.). Wild Turkey Management: Current Problems and Programs. Univ. Missouri Press, Columbia.

Williams, L. E., D. H. Austin, T. E. Peoples, and R. W. Phillips. 1973b. Capturing turkeys with oral drugs. Proc. Natl. Wild Turkey Symp. 2: 219-227.

Williams, T. D. 1978. Chemical immobilization, baseline hematological parameters and oil contamination in the sea otter. PB-283-969, National Technical Information Service, Washington, D. C.

Williams, T. D. 1990. Sea otter biology and medicine. *In* Dierauf, L. A. (ed.). CRC Handbook of Marine Mammal Medicine: Health, Disease, and Rehabilitation. CRC Press, Boca Raton. Pp. 625-648.

Williams, T. D., and F. H. Kocher. 1978. Comparison of anesthetic agents in the sea otter. J. Am. Vet. Med. Assoc. 173: 1127-1130.

Williams, T. D., A. L. Williams, and D. B. Siniff. 1981. Fentanyl and azaperone produced neuroleptanalgesia in the sea otter (*Enhydra lutris*). J. Wildl. Dis. 17: 337-342.

Williams, T. D., A. L. Williams, and M. Stoskopf. 1990a. Marine mammal anesthesia. *In* Dierauf, L. A. (ed.). CRC Handbook of Marine Mammal Medicine: Health, Disease, and Rehabilitation. CRC Press, Boca Raton. Pp. 175-191.

Williams, T. D., D. M. Baylis, S. H. Downey, and R. O. Clark. 1990b. A physical restraint device for sea otters. J. Zoo Wildl. Med. 21: 105-107.

Williams, T. D., A. H. Rebar, R. F. Teclaw, and P. E. Yews. 1992. Influence of age, sex, capture technique, and restraint on hematologic measurements and serum chemistries of wild California sea otters. Vet. Clin. Path. 21: 106-110.

Williamson, W. V., and J. D. Wallach. 1968. M.99 induced recumbency and analgesia in a giraffe. J. Am. Vet. Med. Assoc. 153: 816-817.

Wilson, D. E. 1988. Maintaining bats for captive studies. Kunz, T. H. (ed.). Ecological and Behavioral Methods for the Study of Bats. Smithsonian, Washington, D.C. Pp. 247-264.

Wilson, G. R. 1974. The restraint of red kangaroos using etorphine-methotrimprazine mixtures. Austr. Vet. J. 50: 454-458.

Wilson, G. R. 1976. Intramuscular anaesthesia in the red kangaroo. Aust. Vet. Pract. 6: 51-62.

Wilson, P., and P. J. Warner. 1976. Chemical restraint in the pine marten. Vet. Rec. 98: 302-303.

Wilson, S. C., D. L. Armstrong, L. G. Simmons, D. J. Morris, and T. S. Gross. 1993. A clinical trial using three regimens for immobilizing gaur (*Bos gaurus*). J. Zoo Wildl. Med. 24: 93-101.

Wilson, V. J. 1967. The use of oripavine hydrochloride (M.99) in the drug immobilization of duiker (*Sylvicapra grimmia*). Arnoldia, National Museums of Southern Rhodesia. 3: 1-6.

Winegardner, S. C., L. B. Dalton, and J. W. Bates. 1977. Capture and transplant of desert bighorn sheep with M-99. Trans. Desert Bighorn Council. Pp. 18-20.

Wisnicky, W. 1940. Anesthesia of fur-bearing animals. No. Am. Vet. 21: 277-279.

Wobeser, G., J. E. C. Bellamy, B. G. Boysen, P. S. MacWilliams, and W. Runge. 1976. Myopathy and myoglobinuria in a wild white-tailed deer. J. Am. Vet. Med. Assoc. 169: 971-974.

Wolfensohn, S. E. 1992. Use of medetomidine-fentanyl-fluanisone combinations in the badger. Vet. Rec. 130: 34-36.

Wolff, W. A., R. W. Davis, and W. V. Lumb. 1965. Chloral hydrate-halothane-nitrous oxide anesthesia in deer. J. Am. Vet. Med. Assoc. 147: 1099-1101.

Wood, F. E., K. H. Critchley, and J. R. Wood. 1982. Anesthesia in the green sea turtle, *Chelonia mydas*. Am. J. Vet. Res. 43: 1882-1883.

Wood, G. W., E. E. Johnson, and R. E. Brenneman. 1977. Observations on the use of succinylcholine chloride to immobilize feral hogs. J. Wildl. Manage. 41: 798-800.

Woods, R., M. Hindell, and D. J. Slip. 1989. Effects of physiological state on duration of sedation in southern elephant seals. J. Wildl. Dis. 25: 586-590.

Woods, R., S. McLean, S. Nicol, and H. Burton. 1994. Use of midazolam, pethidine, ketamine and thiopentone for the restraint of southern elephant seals (*Mirounga leonina*). Vet. Rec. 135: 572-577.

Woodford, M. H. 1972. The use of gallamine triethiodide as a chemical immobilizing agent for the Nile crocodile (*Crocodilus niloticus*). E. Afr. Wildl. J. 10: 67-70.

Woodford, M. H., S. K. Eltringham, and J. R. Wyatt. 1972. An analysis of mechanical failure of darts and costs involved in drug immobilization of elephant and buffalo. E. Afr. Wildl. J. 10: 279-285.

Woodring, M. W. 1978. A low-cost capture system. Mod. Vet. Prac. 59: 837-838.

Woolf, A. 1970. Immobilization of captive and free-ranging white-tailed deer

(*Odocoileus virginianus*) with etorphine hydrochloride. J. Am. Vet. Med. Assoc. 157: 636-640.

Woolf, A. 1974. Recovery of M99 immobilized white-tailed deer and wapiti using low dosages of M50-50. J. Zoo An. Med. 5: 18.

Woolf, A. 1984. Inanition following implantation of a radiotelemetry device in a river otter. J. Am. Vet. Med. Assoc. 185: 15-16.

Woolf, A., and J. H. Swart. 1970. Etorphine hydrochloride: anesthetic for surgery on an elk (*Cervus canadensis canadensis*). J. Am. Vet. Med. Assoc. 157: 641-642.

Woolf, A., H. R. Hays, W. B. Allen, and J. Swart. 1973. Immobilization of wild ungulates with etorphine HCL. J. Zoo An. Med. 4: 16-19.

Woolfson, M. W., J. A. Foran, H. M. Freedman, P. A. Moore, L. B. Shulman, and P. A. Schnitman. 1980. Immobilization of baboons (*Papio anubis*) using ketamine and diazepam. Lab. An. Care. 30: 902-904.

Work, T. M., R. L. DeLong, S. R. Melin, and T. R. Spraker. 1992. The use of halothane anesthesia as a method of immobilizing free-renging California sea lions (*Zalophus californianus*). Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. Pp. 57.

Work, T. M., R. L. DeLong, T. R. Spraker, and S. R. Melin. 1993. Halothane anesthesia as a method for immobilizing free-ranging California sea lions (*Zalophus californianus*). J. Zoo Wildl. Med. 24: 482-487.

Wright, F. H. 1981. Use of diazepam as an adjunctive agent in Przewalski horse immobilization. Proc. Am. Assoc. Zoo Vet. Pp. 109-112.

Wright, J. F. 1959. Treatment of captive wild animals using an automatic projectile type syringe. Vet. Med. 54: 32-33.

Wright, J. F. 1962. Immobilization of wild animals. Vet. Med. 57: 331-332.

Wright, J. F. 1963. Chemical restraint of exotic animals in a disease regulatory program. Can. J. Comp. Med. Vet. Sci. 27: 13-16.

Wright, J. M. 1983. Ketamine hydrochloride as a chemical restraint for selected small mammals. Wildl. Soc. Bull. 11: 76-79.

Wright, M. 1982. Pharmacologic effects of ketamine and its use in veterinary medicine. J. Am. Vet. Med. Assoc. 180: 1462-1471.

York, W. 1973a. Pharmacological restraint of felids. World's Cats. 1: 213-216.

York, W. 1973b. Immobilization of a hippo. Proc. Am. Assoc. Zoo Vet.

York, W. 1975. Fentanyl citrate for wild animal capture. J. Zoo An. Med. 6: 14-15.

York, W., and C. Kidder. 1971. Chemical restraint and castration of an adult giraffe. J. Zoo An. Med. 4: 17-21.

York, W., and K. Huggins. 1972. Rompun (Bay VA 1470). J. Zoo An. Med. 3: 15-17.

Youatt, W. G., and A. W. Erickson. 1959. Some effects of sodium pentobarbital anesthesia on juvenile black bears. J. Wildl. Manage. 23: 243-244.

Young, E. 1966a. The use of tranquillizers, muscle relaxants and anesthetics, as an aid in the management of wild carnivors in captivity. Twenty-five case reports. J. So. Afr. Vet. Assoc. 37: 293-296.

Young, E. 1966b. Use of anaesthesics in the transport of animals. Intl. Zoo Yb. 6: 273.

Young, E. 1972. Notes on the chemical immobilization and restraint of the Addo elephant (*Loxodonta africana*). Koedoe 15: 97-99.

Young, E. (ed.). 1975. The Capture and Care of Wild Animals. Ralph Curtis Books, Hollywood, Florida. 224 pp.

Young, E., and B. L. Penzhorn. 1972. The reaction of the Cape mountain zebra (*Equus zebra zebra*) to certain chemical immobilization drugs. Koedoe 15: 95-96.

Young, E., and I. J. Whyte. 1973. Experiences with xylazine hydrochloride (Rompun, Bayer) in the capture, control and treatment of some African wildlife species. J. So. Afr. Vet. Assoc. 44: 177-184.

Young, E., P. J. Burger, and I. J. Whyte. 1972. The use of doxapram hydrochloride on newly-captured wild animals. Vet. Clin. 11: 11-13.

Young, R., and H. M. Kaplan. 1960. Anesthesia of turtles with chlorpromazine and sodium pentobarbital. Proc. An. Care Panel. 10: 57-62.

Young, R. A., and E. A. H. Sims. 1979. The woodchuck, *Marmota monax*, as a laboratory animal. Lab. An. Sci. 29: 770-780.

Yu, B., and Z. Yu. 1987. Anesthetic treatments of the giant panda. *In* Proceedings of Therapeutics of the Giant Panda. China Forestry Publishing House. Pp. 51-53. (Chinese)

Zabarain, C. 1985. [Chemical immobilization of *Odocoileus virginianus* and *Cervus nippon* with xylazine]. Veterinaria (Mexico City). 16: 70.

Zaniewski, L. 1967. The immobilization of European bison x cattle hybrid with suxamethonium. Acta Theriol. 12: 471-474.

Zatzman, M. L. , and G. V. Thornhill. 1988. Effects of anesthetics on cardiovascular responses of the marmot, *Marmota flaviventris*. Cryobiology. 25: 212-226.

Zhu, B. R., and J. Wang. 1992. Comparative studies on anaesthesia of giant panda using ketamine and its combination. Acta Zool. Sin. 38: 230-232.

Zinn, R. S., A. A. Gabel, and R. B. Heath. 1970. Effects of succinylcholine and promazine on the cardiovascular and respiratory systems of horses. J. Am. Vet. Med. Assoc. 157: 1495-1499.

Zomborszky, Z., J. Hafner, and T. Feher. 1993. Values of serum cortisol concentration studies on the stress-sensibility and adaption ability of red deer with intensive keeping. Magy Allatorv Lapja (Hung.) 48: 91-95.

Zuba, J. R., and J. L. Allen. 1992. Affordable, portable, noninvasive monitoring equipment and its place in zoo and wildlife anesthesia. Proc. Joint Conf. Am. Assoc. Zoo Vet. and Am. Assoc. Wildl. Vet. Pp. 230-234.

Zurowski, W., and M. Sakowicz. 1965. Effects of succinylcholine chloride on wild boars. J. Wildl. Manage. 29: 626-629.

Glossary

Adjuvant - Pharmacological agent added to a drug to increase or aid its effect
Agonist - Drug capable of combining with receptors to initiate drug actions
Akinesia - Loss of motor response due to paralysis of motor nerves
Alpha-adrenergic - Drugs that mimic the actions of the sympathetic nervous system that employ norepinephrine as their neurotransmitter
Amnestic - Agent causing amnesia
Analgesia - Loss of sensitivity to pain
Anesthesia, General - Loss of ability to perceive pain associated with loss of consciousness
Antagonist - Drugs that neutralize or impede the action or effect of others
Apnea - Absence of breathing
Apneic - Related to or suffering from apnea
Arrhythmia - Loss of rhythm, especially an irregularity of the heart beat
Auscultation - Listening to the sounds made by the various body structures
Benzodiazepine - Compounds with sedative, antianxiety, anticonvulsant, and muscle relaxant properties
BP - Blood pressure
Bradycardia - Slowness of the heart beat
Bronchospasm - Contraction of the smooth muscles of the walls of the bronchi and bronchioles causing narrowing of the lumen
BT - Body temperature
Catalepsy - State of malleable rigidity of the limbs.
Cerebration - Activity of the mental processes
CNS - Central nervous system
Congener - A member of the same class or group
Contralateral - Relating to the opposite side
CRT - Capillary refill time
Cyanosis - A dark bluish or purplish coloration of the skin and mucous membranes due to deficient oxygenation of the blood
Cyclohexane - Dissociative anesthetic
Cycloplegia - Loss of power in the ciliary muscle of the eye
Distal - Situated away from the center of the body
Endogenous - Originating or produced within the organism
Exogenous - Originating or produced outside of the organism
GABA - Gamma-aminobutyric acid; a neurotransmitter in the CNS
Gm - Gram
Hepatotoxic - Relating to an agent that damages the liver
HR - Heart rate
Hyperglycemia - Abnormally high concentration of glucose in the circulating blood
Hyperkalemia - Abnormally high concentration of potassium ions in the circulating blood

Hyperthermia - Unusually high body temperature
Hyperventilation - Abnormally fast or deep respiration
Hypnosis - Artificially induced sleep or state resembling sleep.
Hypocalcemia - Abnormally low concentration of calcium in the circulating blood
Hypoglycemia - Abnormally low concentration of glucose in the circulating blood
Hypokalemia -Abnormally low concentration of potassium ions in the circulating blood
Hypotension - Low blood pressure
Hypothermia - Unusually low body temperature
Hypoxia - Decrease below normal levels of oxygen in the blood or tissue
IC - Intracardiac; within the chambers of the heart
IM - Intramuscular; within the substance of the muscle
IP - Intraperitoneal; within the peritoneal cavity
IV - Intravascular; within the lumen of blood vessels
Kg - Kilogram
Lateral - On the side away from the median plane
Lb - Pound
Medial - Relating to the middle or center
Mg - Milligram
Ml - Milliliter
Mydriasis - Dilation of the pupil
Myoglobinuria - Excretion of myoglobin in the urine
Narcosis - Sedation in which the animal is oblivious to pain with or without hypnosis
Nephrotoxic - Relating to an agent that damages the kidney
Neuroleptanalgesia - Amnesia and analgesia produced by a combination of a neuroleptic drug and a narcotic analgesic drug.
Neuroleptic - Antipsychotic drug causing suppression of spontaneous movements with retention of spinal reflexes and pain-avoidance behavior
Neuropathy - Any disorder affecting any segment of the nervous system
Nociceptive - Capable of appreciation or transmission of pain
Opioid - Drug that has opium- or morphine-like properties
Paresis - Partial or incomplete paralysis
Patent - Open, exposed
Peritonitis - Inflammation of the peritoneum
Phenothiazine - Antipsychotic drug
PO - Per os; orally
Polyuria - Excessive urination
Proximal - Nearest the trunk or point of origin
RR - Respiratory rate
SC - Subcutaneous
Sedation - See tranquilization.
T1/2 - Half-life; the period of time during which the concentration of a substance in the blood is reduced to one-half of its initial concentration
Tachycardia - Rapid beating of the heart

Tachypnea - Rapid breathing

Therapeutic Index - The ratio of the drug dose that causes death in one-half of the sample population (LD50) to the drug dose that causes the desired effect in one-half of the sample population (ED50)

Tranquilization - State of calmness in which the animal is relaxed, awake and unconcerned about its surroundings and may be indifferent to minor pain

English-Metric Weight Conversion Table

The doses presented in this handbook are presented on a body weight basis which are expressed in the metric system (grams, kilograms). For those not familiar with the metric system, the below table is a relatively simple method for converting pounds to kilograms without the use of a calculator.

To use this table, first estimate the animal's weight in pounds. Then break this weight down into single units, units of 10 or units of 100. Converts these "unit weights" into kilograms and then add them back together for the total weight in kilograms. Weights >10 pounds have been rounded off for simplicity. For example:

1. Body weight of animal in pounds: 450 lb
2. Break this weight down into units and convert pounds into kilograms: 400 lb = 181 kg
   50 lb = 23 kg
3. Sum the kilogram weights: 204 kg

Pounds	Kilograms	Pounds	Kilograms
1	0.5	100	45
2	0.9	200	91
3	1.4	300	136
4	1.8	400	181
5	2.3	500	227
6	2.7	600	272
7	3.2	700	318
8	3.6	800	363
9	4.1	900	408
10	4.5	1000	454
20	9		
30	14		
40	18		
50	23		
60	27		
70	32		
80	36		
90	40		